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FIFTH ANNUAL REPORT

OF THE

STATE BOARD

OF

HEALTH, LUNACY, AND CHARITY

OF MASSACHUSETTS.

SUPPLEMENT

CONTAINING THE

REPORT AND PAPERS ON PUBLIC HEALTH.

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NOTICE.

In consequence of oft-repeated requests for copies of a Public Health Supplement to the Third Annual Report of the State Board of Health, Lunacy, and Charity (1881), the announcement is hereby made, that NO SUPPLEMENT was issued for that year. Hence the following is the correct order of the series as issued :—

1. Supplement to the *First* Annual Report of the State Board of Health, Lunacy, and Charity, . . . 1879
2. Supplement to the *Second* Annual Report, . . 1880

None issued for 1881.

4. Supplement to the *Fourth* Annual Report, . . . 1882
5. Supplement to the *Fifth* Annual Report (present issue), ... 1883

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GENERAL REPORT.

The Public Health Supplement to the Fifth Report of the State Board of Health, Lunacy and Charity, herewith presented, contains the papers presented in relation to such investigations as have been made for the Board during the year 1883, including the reports of the analysts relative to the work which had been done during the year, in compliance with the acts of 1882 and 1883 relative to food and drug inspection.

Tubular Wells for Domestic Water Supply.

Mistaken notions as to the purity of the water in wells used for domestic water supply are of very common occurrence. Mysterious and unfounded ideas as to the direction of water currents, and the character of soils, and also as to the immunity of driven wells from pollution, have often come to the notice of the Board.

The excellent paper by J. C. Hoadley, C. E., a former member of the Board, conclusively shows that such wells are subject to the same conditions, as to the flow of underground water, depression of water-level by pumping, and other causes, as are true of open wells, and consequently such wells are subject to the same laws with reference to water pollution.

The use of wells as sources of domestic water supply in crowded villages, where the ground is perforated in all directions with vaults and cesspools, old and new, is fraught with great danger, and the liability to the production of infectious diseases, through the medium of well-water, becomes increased with the density of the population.

In some localities, where the population is dense and the water of wells is generally contaminated, as shown by chemical analysis, and also by its effect upon the health of those who use it as drinking-water, such wells have been condemned for public use, and closed or filled, and their use prohibited.* Where public water supplies of undoubted purity are at hand their use may be advised, since the presumption of greater purity is usually in their favor. In the absence of such supply a new well may be dug at a safe distance from all polluting causes. If such a course is impossible in consequence of density of population, resort may be made to rain-water cisterns made absolutely water-tight, to prevent the possibility of pollution from the surrounding soil, when sunk below the surface. Even in the case of these receptacles, care must also be taken to avoid the entrance of polluting material, the need of such care being shown in recent reports of the Board.†

Epidemics of typhoid fever and diphtheria have been traced to polluted wells as a direct source or medium of infection. Previous reports of the Board give abundant testimony to this statement, which is also confirmed by constantly recurring instances in other places. Even in the case of epidemics traceable to a milk supply, a careful inspection usually reveals a polluted well or stream as the primary medium of communication.

A degree of personal pride as to the purity of a domestic water supply is common to the multitudes of well-owners, and so long as immunity from illness is enjoyed, the owner believes himself and his family to be secure, until an epidemic of disease awakens him to the importance of attention to the sources of pollution surrounding his water-supply. Chemical analysis alone is not sufficient to determine the purity or impurity of a water supply. The experiments of Dr. R. Cory, performed under the direction of the Local Government Board of England, have demonstrated that dangerous quantities of typhoid fever excreta (such, for instance, as gave rise to the Caterham epidemic in England) may enter a water supply, and still defy the skill of the chemist.

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* Eleventh Report of State Board of Health of Mass., p. 34. Report on Polluted Wells in Brooklyn, by Dr. J. H. Raymond, Health Commissioner. Brooklyn: 1884.

† Fourth Report of State Board of Health, Lunacy and Charity. Supplement on Public Health, pp. 244-245.

Dr. Buchanan, in commenting upon Dr. Cory's experiments, says, "The lesson is taught afresh and significantly, by Dr. Cory's report, that while we must always be on the watch for the indications that chemistry affords of contaminating matters gaining access to our waters, we must (at any rate until other methods of recognition are discovered) go beyond the laboratory for evidence of any drinking-water being free from dangerous organic pollution. Unless the chemist is well acquainted with the origin and liabilities of the water he is examining, he is not justified in speaking of a water as 'safe' or 'wholesome,' if it contains any trace whatever of organic matter; hardly indeed, if it contains absolutely none of such matter appreciable by his very delicate methods. The chemist can, in brief, tell us of *impurity* and *hazard*, but not of *purity* and *safety*. For information about these, we must go, with the aid of what the chemist has been able to teach us, in search of the conditions surrounding water sources, and affecting water services." *

While the paper of Mr. Hoadley relates especially to wells, and particularly to tubular wells, and proves the necessity of special need of care on the part of the private citizen, in the selection and the protection of his water supply, it is also true that the public supplies are often exposed to similar contaminating influences, and it therefore becomes the duty of public authorities to guard every avenue of approach by which such supplies are menaced.

In the absence of abundant and accessible supplies, tubular wells are occasionally resorted to as a mode of public water supply. Hence it is obvious that the greatest care is necessary in the selection of a safe location in every case.

HEALTH OF TOWNS.

In the cities, and also in many of the large towns of the State, local boards of health have been organized in compliance with the provisions of the statutes, and have done efficient service in the local sanitation of their respective municipalities. But there are still many large towns, and also the greater portion of the smaller towns, in which no independent boards exist. In such towns the boards of selectmen are, *ex officio*, the boards of health, and while a board so constituted may prosecute the sanitary work of a town efficiently, it is also true that such boards are quite as often a hindrance to successful sanitation. Hence, the election of independent local boards, having at least one medical officer as a member, is deemed a measure of the highest importance.

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* Eleventh Report of the Local Government Board. Supplement, p. xxi.

In order to ascertain the present status of city and town authorities with reference to the existence of local boards, a circular was issued during the year, requesting replies as to the existence or non-existence of such boards.

Replies were received from 295 cities and towns, of which number 147 appear to have elected independent boards, and in 148 the selectmen constituted the boards of health. Of the cities, two only were without independent boards, the mayor and aldermen in these constituting the boards of health. Of the smaller towns from which no replies were received, it would be safe to say that nearly all are without independent boards.

It is desirable, in the public election of town officers, that in all cases where boards of health are not elected, the selectmen, in assuming their official duties, should be fully aware of their responsibility under the provisions of chap. 80, sect. 3, and should be held responsible for the faithful performance of such duties as are required by the Public Statutes with reference to local sanitation.

The failure of towns to take such action, and the constant disregard of statutory requirements by existing boards, not primarily constituted with reference to sanitary executive work, is a source of constant complaint, and appeals to the State Board for the protection of local interests, where local officers thus constituted exist, are matters of frequent occurrence.

In several of the cities special reports have been made relative to the sanitary condition of the public schools, showing a commendable interest in this most important branch of sanitary work. Special committees have had such work in charge in Lynn, Salem, and Newton, and good results have been secured. Frequent cases have come to the notice of the Board in which gross neglect as to the condition of the buildings in which public schools are wont to assemble daily has been evident. Ventilation, heating, lighting, drainage, restrictions as to contagious diseases, all require careful attention, that the conditions essential to health may be secured for all the young who spend five or six hours per day, during the period of rapid growth, in the public schools.

The paper entitled, "The Sanitary Condition of Somerville," by Dr. John F. Couch, illustrates the work of an efficient local board, during several years of its existence, in regard to matters pertaining to nuisances, offensive trades, drainage, the restriction of infectious diseases, and other important matters.

In addition to the article on the Health of Somerville, another paper contains the result of certain inquiries and reports relative to the sanitary condition of Nantucket, together with the action of the town with reference to the introduction of a general plan of sewerage, a measure which it is hoped may be accomplished at no distant day.

THE MORTALITY REPORTS OF MASSACHUSETTS CITIES AND TOWNS.

For several years the Board has published the reports of mortality received from the cities and towns of the State, the same having been compiled for weekly publication. These reports have represented the mortality of the cities and large towns chiefly, and, with the exception of one or two years, no annual compilation of the results has been made. For the purpose of obtaining a more complete report, which should represent the smaller, agricultural districts, as well as the populous cities and towns, an appeal was made during the past year to every town in the State to contribute toward the general result. The effect of this appeal was to obtain a considerable increase in the returns. About one hundred cities and towns are now reporting weekly.

Although these reports are derived from the same original data with the registration reports, they differ from them in point of completeness, while their comparative results are quite similar.

A careful comparison of the mortality reports, contained in the reports of the State Board and in the registration reports, is instructive as illustrating to a certain extent the comparative fatality of certain diseases, as they have prevailed during the year throughout the entire State, as compared with their prevalence in the more densely inhabited portions covered by the weekly returns.

The harmony of the two reports is more evident in the case of the more destructive diseases, such as consumption, diarrhœal diseases, typhoid and scarlet fevers, than in the case of those which are less destructive to life.

The total number of deaths obtained from the weekly mortality reports (23,056) gives a greater death-rate than that of the entire State, in consequence of the preponderance of the urban population represented in the former, the death-rate of the reporting population (1,111,500, including all the cities), being 20.7 per 1,000 for the year, as against 19.01 for the entire State.

This discrepancy is greater when the deaths under five years of age are considered; the death-rate of this class in the reporting population being 7.3, while that of the registration reports for the entire State is 5.9 per 1,000 of the living population.

In the case of consumption, the results are very close, showing that the disease is quite equally distributed throughout the State. In the one case (of the reporting population), the deaths from this disease were 157.2 per 1,000 of all deaths, and in the other (the entire State) 157.1.

The difference in the case of typhoid fever is a little greater, — 20.9 per 1,000 of all deaths in the reporting cities and towns, and 22.8 in the entire State, thus illustrating the greater prevalence of this disease in the smaller towns, not provided with public water supplies and systematic drainage.

In the case of two of the diseases of less fatality the variation in ratio is such as to require comment. The number of deaths reported to the State Board from puerperal fever, from the estimated population of reporting cities and towns, was the same as that stated in the registration report for the entire State. This would appear to prove that this disease, for the year 1883, at least, was mainly a disease of the populous cities and towns, and not of the sparsely settled districts. On further reference to the registration reports this statement is confirmed. Five smaller counties have reported two cases only out of the total of 127.

The singular discrepancy in the case of cerebro-spinal meningitis, in which the larger number of deaths is reported from the smaller population, can only be accounted for by the fact that this disease is reckoned among infectious diseases, and has thus far been printed upon the cards issued by the Health Department, and the printed name among a few specified infectious diseases may have misled non-professional officials to record other deaths from meningeal disease under this title upon the cards, thus considerably increasing the actual number.

Malarial fever is shown by the comparison of the reports to be a disease confined mainly to a limited territory. The four western counties, containing one-eighth of the population of the State, reported 42 deaths from the malarial fevers, or more than one-half of the entire number of deaths from these diseases. Of this number, Hampden County furnished 30, Hampshire 8, Franklin 3, and Berkshire 1.*

It is to be hoped that this section of the State will in the future furnish complete weekly returns to the State Board, especially with reference to the prevalence of malarial disease.

Inspection of Food and Drugs.

During the past fifteen years the State Board of Health of Massachusetts, and also the present Board, have made occasional investigations as to the quality of the food supply of the State. Special reports were made, as the result of investigations, by Prof. H. B. Hill, Dr. Arthur H. Nichols, and Prof. James F. Babcock, and published in the third and fourth reports of the State Board of Health. More recently, reports were made to the present Board by Mrs. Ellen H. Richards (published in the supplement to the First Report of the State Board of Health, Lunacy, and Charity), and by Prof. S. P. Sharples (published in the supplement to the Fourth Report of the same Board).

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* Forty-second Registration Report, 1883.

The requirements of the statutes of the past two years have changed the character of the work of the Board from that of simple investigation to that of execution; and while constant investigation as to the quality of the food supply has been continued, and is still in progress, special attention has been directed to those articles of food which are found to be most liable to adulteration.

The inspection of drugs, which has also continued throughout the year, has also revealed a considerable need of improvement in this direction, in consequence, not so much of an actual substitution of cheaper ingredients in drugs, as is often the case with regard to articles of food, but rather because of a want of definite and uniform strength, as required by the United States Pharmacopœia, and as a result of the omission of a part, or the whole, of valuable constituents.

The examinations made by the analyst of drugs show that an improvement has already resulted from the recent action of the Board. Supplies of drugs are selected with greater care, and manufacturers also find it necessary that officinal products should conform to the requirements laid down in the United States Pharmacopœia.

The work done during the year will be found detailed by the analysts of the Board, who were appointed under the act of 1882 (Dr. E. S. Wood of Harvard Medical School, and Dr. B. F. Davenport of the Massachusetts College of Pharmacy). In addition to these, and in compliance with the statutes of 1883, two analysts were also appointed for the special duty of carrying out the provisions of the statute of 1883 relating to the adulteration of milk. The analysts so appointed were Dr. Charles Harrington and Prof. Chas. A. Goessmann. The former was instructed to continue the work relative to milk adulteration in eastern Massachusetts, and the latter in the western part of the State.

In addition to the acts above referred to, which were published in the supplement to the Fourth Report of the Board (pp. xvii–xix), an amendatory act was passed by the legislature of 1884, enlarging the powers of the Board, and making certain modifications in the act of 1882. The act of 1884 may be found in full on page 93 of this report.

TRICHINOSIS.

Cases of this disease in Massachusetts have thus far been of rare occurrence, the entire number reported in the State for a period of fifteen years being but twenty-three, with one death only.

At no time has the disease affected large numbers of people on this side of the Atlantic. The habits of the people here, as to the partaking of raw meat, are very different from those of certain sections of Germany, where, in some epidemics, several hundred people have been infected at once in consequence of eating the flesh of a single trichinous animal. The facts thus far presented in relation to trichinosis, are all in support of the view that it is a preventable disease, and that the *thorough cooking of all swine's flesh intended for use as food* is requisite for its prevention.

ARSENIC AS A DOMESTIC POISON.

In the Third Annual Report of the State Board of Health of Mass. (1872), a very carefully prepared paper was published, on the "Effects of Arsenic in Certain Green Colors," in which the author, Dr. F. W. Draper, showed that many of the green colors employed in the manufacture of wall-papers and also for various other purposes, contained variable quantities of arsenic, and that serious cases of poisoning had occurred and were liable to occur in consequence of the use of such paper.

Since the publication of that report, and in consequence of the continued presentation of the subject by boards of health, chemists and others, green pigments in papers and for other purposes are not so indiscriminately employed as in earlier years.

In continuation of the same subject, the full and complete article, entitled "Arsenic as a Domestic Poison," prepared for the present report by Prof. Edward S. Wood, emphatically demonstrates that the arsenical colors as now employed are not limited to green, but may be found of every hue. The various sorts of paper which are colored with arsenical pigments are used for a multiplicity of purposes in every-day life; and many other articles, such as textile fabrics, clothing, candles, toys and confectionery, are colored with this dangerous pigment.

The processes employed in the manufacture of dyes are detailed. The effects of the poison, both acute and chronic, local and general, are all clearly stated, together with the difficulty of diagnosis, and the probability that many cases are overlooked and referred to other causes.

Recent reports of well-known authorities are cited. A list of illustrative cases is also presented, in which are set forth the various forms in which people are exposed to danger from the poison, and also the varied and distressing symptoms presented in its victims.

A valuable summary of the various statutes of different countries shows the progress made among foreign nations in the restriction of the evil.

The article concludes with a detailed statement of the tests employed for the detection of arsenic by various methods, including that of the writer.

Offensive Trades.

No complaints have been made to the Board during the past year with reference to such trades as have been specified in the statutes as offensive. Action has been taken by local boards, resulting in the suppression of certain establishments, the modification of others, and the removal of others to a reasonable distance from populous neighborhoods.

The process of charcoal-burning may become offensive in certain localities, favorable to such a condition, as may be inferred from the following statement as to the kilns erected by the Richmond Iron Company at Zoar, in the town of Charlemont, in Franklin County, already briefly alluded to in the General Report of the Board. (Fifth Report of the State Board of Health, Lunacy and Charity, page lxxviii.)

At the place in question are three charcoal-kilns, built of brick. Each kiln is about 35 feet in diameter and 12 in height, and has a capacity of from 75 to 90 cords of wood. Each kiln after being fired is kept burning for about ten days, during which time great quantities of smoke, gas and watery vapor escape into the air.

There are special conditions existing at Zoar which seem to favor the accumulation of smoke in the neighborhood of the kilns and of the population who complain of them.

1. Topographically. The kilns are located in a crooked valley, where they are shut in by high hills, which prevent the free exit of the smoke and other products of combustion. In dull weather, when there is not much brisk wind, the smoke rises in the air a short distance and then settles as a cloud about the neighboring houses, considerable quantities passing over an intervening hill toward the Deerfield River. The direction of the valley of the Cold River, in which the kilns are situated, is quite crooked, first running southerly and then east and northerly toward the Deerfield Valley. The natural conformation of the place is such as to prevent the occurrence of high winds, and to favor the retention of the smoke, or to allow its escape down the valley toward the inhabited houses.

2. The amount of fuel converted into charcoal is large. Each kiln holds about 80 cords, weighing at least 125 tons. In the process of burning, at least an average of 75 per cent. in weight is lost, this loss in weight being made up of watery vapor, carbonic acid and carbonic oxide, empyreumatic vapors and carbon in the form of smoke to the amount of 75 tons or more from each kiln of burning wood.

The following table shows the weight per cord of common sorts of wood employed in making charcoal, with the weight of charcoal obtained, and the consequent loss in process of burning: —

	Weight per Cord. Pounds.	Per Cent. of Charcoal.	Pounds of Charcoal per Cord.	Loss per Cord. Pounds.
White Birch, ...	2,369	19.	450	1,919
Walnut, ...	4,469	26.2	1,172	3,297
Sugar Maple, ...	2,878	21.4	617	2,261
White Oak, ...	3,821	21.1	826	2,995
Red Oak, ...	3,254	22.4	630	2,624
Chestnut, ...	2,333	25.3	590	1,743

The symptoms presented by the persons affected and living in the immediate neighborhood of the kilns, are nausea, headache, bronchial irritation, smarting taste, irritation of the eyes, sore throat, — these symptoms being relieved when the fires are stopped.

For the purpose of ascertaining, if possible, more definitely the character and the quantity of the noxious gases evolved from the kilns and present in the air of the neighborhood, examinations of the air were made under the direction of Prof. W. R. Nichols, of the Massachusetts Institute of Technology, from whose report to the Board the following statement is herewith presented: —

"As to the chemical character of the substances sent into the air from the kilns, the carbonic oxide and carbonic acid would diffuse more readily into the air than the empyreumatic substances, such as creasote, &c., which are probably the most disagreeable.

"In making chemical examinations, we labored under a good many disadvantages, owing to the season of the year and the remoteness of laboratory facilities. It seemed to me that although the carbonic acid was not the most important of the substances that would come from the kilns, it would be better to make a number of determinations of carbonic acid in the air, and if no abnormal condition of things was thus discovered, it would be hardly worth while to make any extensive tests for carbonic oxide. The determinations of carbonic acid between February 20 and 23 were made by Pettenkofer's method, using absorption tubes; but we found, contrary to what we had expected, that the smoke was evident only at somewhat infrequent intervals, and for short periods of time. On this and other accounts the visit was not as fruitful in results as might be desired. The determinations in Table I. may, however, be put on record.

"During the time spent at Zoar my assistant kept a careful record of the height of the barometer, direction of the wind, temperature of the air, and state of the weather, which, however, it is hardly worth while to incorporate in the report. It will be enough to say that the barometer varied from 29 inches to 29.75 inches, and the temperature was generally between 20° and 40° F. It was evident that a different method must be employed for examining the air, and at the next opportunity which was afforded by the firing of a kiln, my assistant again visited Zoar, and this time employed what we know as Pettenkofer's 'bottle' method, which enabled us to take specimens at any moment, wherever the smoke happened to be, so that the determinations were not all made at the house itself, but at various points in the immediate vicinity. The results of the determination of carbonic acid are given in Table II. If we take the average of the results obtained when the air was perceptibly smoky and compare it with the average of the results obtained when no smoke was perceived, there is little difference, for in the former case we have 3.89 volumes of carbonic acid in 10,000 volumes of air, and in the latter case 3.66 volumes. We must note, however, that the amount of carbonic acid was not likely to be directly proportional to the amount of smoke perceived, because the carbonic acid will diffuse and mix more readily with the air than the substances which constitute the smoke. We have no means of knowing what the average amount of carbonic acid in the air at this locality is; being in a valley where the circulation is somewhat sluggish, it is probable that the normal amount would be over three parts, perhaps as much as three and a half, but where the amount runs over four, I am inclined to think that it is probably due to the effect of the kilns, and where it exceeds five, there can be little doubt of the cause.

"Several samples of air were taken, and afterwards carefully tested in the laboratory for carbonic oxide. In one case we obtained evidence of the presence of a minute amount of this gas. This sample was taken at the same time as the sample numbered 7 in Table II., where the amount of carbonic acid was, with one exception, the largest obtained.

"My opinion in the matter is that the effect of the charcoal-burning in this locality is to alter somewhat the normal character of the air, but not to such an extent that the breathing of the air could be pronounced decidedly injurious, on the strength of the chemical examinations. There is, however, no doubt as to the offensive and disagreeable character of the smoke, which at times penetrates into the house, and especially by night, by its disagreeable character interferes with the proper enjoyment of life. It seems to me that it is essentially the same sort of a question as that which arises in connection with the emanations from rendering establishments, which are undoubtedly offensive, but which it is difficult to show are injurious except so far as they act indirectly upon the system I doubt very much if at the distance from the kilns at which Mr. Hawkes's house is situated, more carbonic oxide is breathed than is breathed by dwellers in the city in winter.

Respectfully submitted.

WM. RIPLEY NICHOLS."

THE KIDDER LABORATORIES,
MASS. INSTITUTE OF TECHNOLOGY,
BOSTON, 17 April, 1884.

TABLE I.

DATE.	Hour.	Barom.	Temp. Fahr.	Vols. CO_2 in 10,000.
1884. February 20, ...	4.15 — 7.15 P. M.	29.33	30.2°	3.49
	10. "	29.45	21.2°	3.41
February 21, ...	9.30 — 12.30 "	29.60	30.2°	2.91
22, ...	10 — 1.40 "	29.69	39.2°	2.78
22, ...	6 — 9 "	29.50	35.6°	3.20
23, ...	7.45 — 10.35 "	29.18	42.8°	3.79

TABLE II.

Number.	LOCALITY.	Date.	Hour.	Vols. CO₂ in 10,000. [Smoky.]	Vols. CO₂ in 10,000. [Not smoky.]	REMARKS.
No. 1,	250 yards east of house,	March 31,	9 P. M.,	3.53	–	Somewhat smoky.
3,	Wood lot, 500 yards from kiln,	April 1,	2.15 “	3.73	–	Strong smell of smoke.
4,	250 yards east of house,	“ 1,	5.45 “	3.73	–	Very smoky.
5,	30 feet east of house,	“ 1,	6 20 “	3 59	–	Quite smoky.
6,	250 yards east of house,	“ 1,	6 50 “	3 69	–	Very smoky.
7,	300-350 yards east of house,	“ 1,	7.15 “	5.26	–	“ “
8,	Saw-mill,	“ 2,	6 20 A. M.,	5.50	–	Somewhat smoky.
9,	75 yards east of house,	“ 2,	11.25 “	–	3.44	No smoke.
10,	“ “	“ 2,	11.25 “	–	4 15	Another sample.
11,	“ “	“ 2,	2 35 P. M.,	–	4 04	No smoke.
12,	“ “	“ 2,	2 35 “	–	3.83	“
13,	30 feet east of house,	“ 2,	8.30 “	3.61	–	Very smoky.
14,	“ “	“ 2,	8 30 “	3 71	–	“ “
15,	“ “	“ 2,	9 “	3.56	–	Somewhat smoky.
16,	75 yards south-east of house,	“ 2,	9 “	4.24	–	Quite smoky.
17,	30 feet east of house,	“ 2,	10 “	3.90	–	Somewhat smoky.
18,	“ “	“ 2,	10.30 “	3.96	–	“ “
19,	House by bridge,	“ 3,	2.15 “	3 36	–	“ “
20,	75 yards south-east of house,	“ 3,	2.45 “	4.23	–	“ “
21,	“ “	“ 3,	3 20 “	–	3.56	Not smoky.
22,	“ “	“ 3,	3.50 “	–	3.18	“
23,	“ “	“ 3,	4.30 “	–	4.66	“
24,	50 yards north of house,	“ 4,	10.15 A. M.,	–	3.62	“
25,	“ “	“ 4,	10.15 “	–	3.03	“
26,	“ “	“ 4,	11.10 “	–	3.22	“
27,	“ “	“ 4,	11.15 “	–	3 50	“
28,	350 yards east of house,	“ 4,	11.30 “	3.17	–	Very smoky.
29,	Saw-mill,	“ 4,	3.50 P. M,	3.37	–	Quite smoky.

CONTAGIOUS DISEASES.

During the year 1883, small-pox has not prevailed in Massachusetts, and but few isolated cases have occurred, with a total mortality of five, two of which were reported from Holyoke, two from Russell, and one from Pepperell.

Notwithstanding this unusual immunity, it is hoped that the usual measures for the prevention of the disease may be unremitting, and that careful vaccination of all infants shall be systematically performed, and also the re-vaccination of adults. One of the chief obstacles in the prevention of small-pox consists in the spasmodic character which such measures are wont to assume, it being the usual custom to wait until an epidemic is either imminent or actually existing. If the proper preventive measures should be carried out with constant uniformity, year after year, epidemics of small-pox would doubtless be regarded as matters of history.

The whole number of cases of small-pox reported to the Board during 1883, was twenty-one, including four deaths. The cases were distributed as follows: —

Boston, ...	8 cases.
Holyoke, ...	3 "
Pepperell, ...	2 "
New Bedford, ...	3 "
Russell, ...	2 "
Lawrence, ...	1 case.
North Adams, ...	1 "
Ludlow, ...	1 "

The time of occurrence was as follows: January, 1; February, 1; March, 7; April, 4; May, 2; June, 3; November, 1; December, 2.

Scarlet fever prevailed with considerable uniformity throughout the year, the mortality from this disease being somewhat in excess of that of 1882, but much less than the average for the past twenty years.

The mortality from diphtheria was less than that of the previous year, and also less than that of any year since 1874, the decrease in mortality having been quite uniform since that date. In the case of both diseases, scarlet fever and diphtheria, the percentage of mortality in Suffolk County was in excess of that of the State.

It is gratifying to learn that greater care is exercised with reference to the spread of contagious diseases in schools generally throughout the State than in former years. Certificates of health are now usually required previous to the admission of children who have been ill with contagious disease.

As will be seen by examination of the following acts of the Legislature of 1884, the powers of school committees have been enlarged so as to give them control of the attendance of scholars who are ill with scarlet fever, diphtheria or small-pox. (Chap. 64, 1884.)

Formerly, small-pox was the only disease specified in the statutes as dangerous to public health, but by the act of 1884 (chap. 98), diphtheria and scarlet fever are also distinctly specified.

The same act also provides for the disinfection of infected apartments by the householder in a manner approved by the Board of Health. It also provides for the registration of all reported cases of contagious disease, and also for the notification of school committees of the existence of such cases.

[Chap. 64, Acts of 1884.]

An Act to prevent the spread of Contagious Diseases through the Public Schools.

Be it enacted, etc., as follows:

The school committees shall not allow any pupil to attend the public schools while any member of the household to which such pupil belongs is sick of small-pox, diphtheria or scarlet fever, or during a period of two weeks after the death, recovery or removal of such sick person. [*Approved March 7, 1884.*

[Chap. 98, Acts of 1884.]

An Act concerning Contagious Diseases.

Be it enacted, etc., as follows:

Sect. 1. When a householder knows that a person within his family is sick of small-pox, diphtheria, scarlet fever or any other disease dangerous to the public health, he shall immediately give notice thereof to the selectmen or board of health of the town in which he dwells, and upon the death, recovery or removal of such person, the rooms occupied and the articles used by him shall be disinfected by such householder in a manner approved by the board of health. Any person neglecting or refusing to comply with either of the above provisions shall forfeit a sum not exceeding one hundred dollars.

SECT. 2. When a physician knows that a person whom he is called to visit is infected with small-pox, diphtheria, scarlet fever or any other disease dangerous to public health, he shall immediately give notice thereof to the selectmen or board of health of the town; and if he refuses or neglects to give such notice he shall forfeit for each offence not less than fifty nor more than two hundred dollars.

SECT. 3. The boards of health in the several cities and towns shall cause a record to be kept of all reports received in pursuance of the preceding sections and such record shall contain the names of all persons who are sick, the localities in which they live, the diseases with which they are affected, together with the date and the names of the persons reporting any such cases. The boards of health shall give the school committee immediate information of all cases of contagious diseases reported to them according to the provisions of this act.

SECT. 4. The secretary of the Commonwealth shall furnish the boards of health with blank books for the record of cases of contagious diseases as above provided.

SECT. 5. Sections seventy-eight and seventy-nine of chapter eighty of the Public Statutes are hereby repealed. [*Approved March 21, 1884.*

The Metric System.

LENGTH.

1 Myriameter,	Mm.	(10,000 m.)	= 6.2137 miles.
1 Kilometer,	Km.	(1,000 m.)	= 0.62137 mile.
1 Hectometer,	Hm.	(100 m.)	= 328.0833 feet.
1 Decameter,	Dm.	(10 m.)	= 393.7 inches.
1 Meter,	m.	(1 m.)	= 39.37 inches.
1 Decimeter,	dm.	(0.1 m.)	= 3 937 inches.
1 Centimeter,	cm.	(0.01 m.)	= 0.3937 inch.
1 Millimeter,	mm.	(0.001 m.)	= 0.03937 inch.

SURFACE.

1 Hectare,	Ha.	(10,000 sq. m.)	= 2.471 acres.
1 Are,	a.	(100 sq. m.)	= 119.6 square yards.
1 Centare,	ca.	(1 sq. m.)	= 1.550 square inches.

CAPACITY.

1 Kiloliter or Stère,	Kl. or st.	(1,000 l.)	= 1 308 cubic yards.	= 264.17 gallons.
1 Hectoliter,	Hl.	(100 l.)	= 2 bush. and 3.35 pecks	= 26.417 gallons.
1 Decaliter,	Dl.	(10 l.)	= 9 08 quarts	= 2 6417 gallons.
1 Liter,	l.	(1 l.)	= 0.908 quart	= 1.0567 qts. (1.761 imperial pints.)
1 Deciliter,	dl.	(0.1 l.)	= 6.1022 cubic inches	= 0.845 gill.
1 Centiliter,	cl.	(0.01 l.)	= 0.61022 cubic inch	= 0.338 fluid ounce.
1 Milliliter,	ml.	(0.001 l.)	= 0.061 cubic inch	= 0.27 fluid drachm.

WEIGHT.

1 Millier or Tonneau,	M. or T.	(1,000 Kg.)	= 1 Kl. or 1 Cu. m.	= 2204.6 pounds (avoirdupois.)
1 Quintal,	Q.	(100 Kg.)	= 1 Hl. or 0.1 Cu. m.	= 220.46 pounds.
1 Myriagram,	Mg.	(10 Kg.)	= 1 Dl. or 10 Cu. dm.	= 22.046 pounds.
1 Kilogram,	Kg.	(1,000 g.)	= 1 l. or 1 Cu. dm.	= 2.2046 pounds.
1 Hectogram,	Hg.	(100 g.)	= 1 dl. or 0.1 Cu. dm.	= 3 5274 ounces.
1 Decagram,	Dg.	(10 g.)	= 1 cl. or 10 Cu. cm.	= 0.3527 ounce.
1 Gram,	g.	(1 g.)	= 1 ml. or 1 Cu. cm.	= 15.432 grains.
1 Decigram,	dg.	(0.1 g.)	= 0.1 ml. or 0.1 Cu. cm.	= 1.5432 grains.
1 Centigram,	cg.	(0.01 g.)	= 0 01 ml. or 10 Cu. mm.	= 0.1543 grain.
1 Milligram,	mg.	(0.001 g.)	= 0.001 ml. or 1 Cu. mm.	= 0.0154 grain.

One kilogram is equal to a weight represented by one liter of distilled water at 4° C. In the centigrade scale 0 (32°+F.) is the freezing point; 100°+(212°+F.) is the boiling point. Five degrees C. corresponds to nine degrees F.

All measures in the metric system are derived from the meter, and their names express their values. Some of the names in the French system (like our "dime") are not in practical use; e.g., hectometer, decagram, etc.

One inch = 2.5 centimeters nearly; one quart (wine measure) = 0.946 liter; one pound Troy = 0.373 kilogram; one acre = 0.4046 hectare.

TUBULAR WELLS AND WELLS IN GENERAL,

AS A SOURCE OF

WATER SUPPLY FOR DOMESTIC PURPOSES.

By J. C. HOADLEY.

TUBULAR WELLS FOR DOMESTIC WATER SUPPLY.

The question of water supply for domestic use, is most commonly treated from the point of view of public water works for the general supply of cities, villages, or other dense populations, by pumps or by gravity flow from an elevated source, through appropriate conduits, mains and service pipes.

The magnitude of such public water works, the magnificence of some of them, and the utility of nearly all, draw attention to such constructions, and secure for them general recognition.

Requiring a high degree of special skill, such works are usually carried out under the supervision of competent engineers, who often give the public the advantage of their ripe experience, and enrich the literature of the engineering profession with contributions of great value. This state of things is not to be deprecated, but is rather to be highly commended. For populous and crowded places, some source of water supply extraneous to the places themselves must usually be very desirable and often imperative, Mischief is sometimes done by introducing a copious water supply in advance of adequate drainage, — the polluted streams of house drains poured into inadequate sewers and delusive cesspools, to poison the surrounding soil, and through the diffusion of dangerous, sometimes fatal effluvia, causing injury to the public health outweighing, perhaps, the advantages of pure and abundant water. A little extravagance — for the most part harmless — is now and then indulged in through ostentation or defective judgment, in the erection of costly reservoirs and elegant pumping stations; but even these, once paid for, become objects of honest pride to the citizens, and would rarely be relinquished for a return of their cost many fold.

New works of this character will be constructed year by year in communities yet unsupplied; and in the great cities, systems more vast and more superb than any hitherto undertaken, will yet be accomplished. Boston, and the cities on the Merrimack (Lawrence, Lowell, Manchester), and, perhaps, other places, may some day be supplied with unfailing streams of uncontaminated water from Lake Winnipiseogee; New York and the intervening cities from Lake George, and San Francisco from Lake Tahoe. But when all is done, no less than at the present time, the great reliance of the rural population, including, of course, that large and increasing portion of the population of cities which passes a part of the year in the country, must be, as it now is, upon wells.

In almost all places fitted for human habitation, water is to be obtained at a greater or less depth below the surface of the ground. Wherever found, it has fallen from the clouds, has sunk into the ground through permeable soil, and having reached some impermeable stratum, such as impenetrable clay or hard, unbroken rock, is creeping with stealthy flow, through the interstices of the soil to lower levels, on its way, by some path more or less obstructed, to the sea.

Wherever precipitation exceeds evaporation, it is impossible that there should ever be a cavity below the sea level, unfilled with water, unless artificially emptied; and even in localities where evaporation from the surface greatly exceeds precipitation, the copious showers of the rainy season, deeply sunk in the permeable soil, and protected from rapid evaporation by the dry earth above their surface, although constantly flowing seaward, maintain an unfailing supply for human needs within easy reach. In parts of California, where rain seldom falls between March and December, where a temperature of 96° to 104° F. by day, and 70° to 75° by night prevails for almost half the year, with drying winds and cloudless skies, the water soon drains and dries away from the natural drainage channels, and sinks down in the adjacent soil below the level of their beds, leaving at most but here and there a pool in their deeper portions, stagnant, but for the almost imperceptible underground flow.

These channels, often a hundred feet, sometimes several hundred feet in width, and twenty to fifty feet deep, called "sloughs," (*sloos*), are skirted by bushes, and covered in summer with rank vegetation. But the rainfall of the rainy season, re-enforced by that which drains down from the numerous mountain ranges into the broad valleys, fills the ground up to a level higher than the beds of these sloughs, along which streams then flow as in ordinary rivers, and the sloughs assume the character of a complete system of natural drainage. Flowing along these channels with less obstruction than through the interstices of the soil, the water in these streams is lower than the surface of the adjacent ground water, which therefore drains into them, yet continues its obstructed flow by their side at a higher level. In the great valley of the Sacramento the general slope of the ground is about four feet in a mile, and the water in the ground preserves about the same slope, and flows for miles in width beneath the surface of the ground in the same general direction that the river pursues between its banks, but with greatly reduced velocity, and at a level higher in proportion to its remoteness from the open channel, towards which it also tends. Wherever the level of this sheet of underground water is reached, an unfailing supply is secured.

The ordinary method of getting at this water, is by boring a hole with a pod-auger, and dropping a tube of 1½-inch gas-pipe into it — the work of two men for half a day, when the depth does not exceed fifty feet. But open wells are also made with equal success, though at greater cost; and deeper wells are sometimes sunk, passing through one and occasionally through two impervious beds of clay to different strata of water-bearing sand or gravel, all filled with water of substantially the same character and temperature, derived from the same source — the rains of winter, all flowing in the same direction to seek the same outlet, and all rising to the same height in the tubular wells — allowance made for difference of location.

In such cases the problem of well-sinking for water-supply is extremely simple. Other conditions, often of great complexity exist in parts of California. I have spoken only of what has fallen within my own observation, in the great valleys of the Sacramento and American rivers. In most parts of the Northern, Eastern and Middle States, in which the softened materials of decomposed granite, conglomerate and other hard rocks have been disturbed by the action of vast accumulations of ice, and swept into moraines and beds of glacial drift, the conditions under which water is found below the surface of the earth are extremely various.

Sometimes — the cases are exceptional, but not very rare — a permeable bed of sand or gravel not far from level, extends in all directions to natural drainage channels — brooks, ponds, rivers, or the ocean — affording, when not sealed by frost, free reception and secure storage for a large part of the rain-fall. Some water runs directly off from the surface into the drainage channels, during violent showers and when the ground is frozen; some, falling in small quantities upon warm, dry ground, is soon reëvaporated; but in large part, rain-fall upon such homogeneous, permeable soil, unfrozen, sinks quietly down upon the surface of the water already filling the pores and interstices of the ground up to a certain level. The aggregate volume of these interstices is nearly the same in all soils. Sand, whether coarse or fine, and gravel of whatever size, when sifted out so as to consist of grains or pebbles of nearly uniform size, approximately spherical in form, and when well compacted, have about 60 per cent. of their volume occupied by solid materials, and about 40 per cent. by cavities which must, in all natural conditions, be filled with either air or water. When grains and pebbles of varying dimensions are mixed together, as is the case in nearly all natural sands and gravels, the finer portions occupy to a certain extent the interstices of the coarser portions, and the proportions become about 63 per cent. solid to 37 per cent. vacant, or filled with either air or water. These proportions hold good for very fine quicksands, appearing, when taken from their beds, like clay, or cream, yet when dried exhibiting under the microscope the character of true sand, and revealing — in New England — their origin in triturated granite, the quartz and felspar reduced to shining transparent and nacreous pebbles, and the mica comminuted to an impalpable powder. I have discerned this character in quicksand where the grains were less than $\frac{1}{1000}$ of an inch in diameter.

Clays, even when nearly impervious to water — forbidding its transmission although permitting its absorption — really possess as much open space, in the aggregate, as sands and gravels, as is proved by their specific gravity, which is substantially the same for all three; while the solid materials of all are, again, of substantially equal specific gravity; but in many clays the interstices between the extremely minute solid particles are too small to admit the passage of water through them. In very fine quicksand, water, it is true, freely penetrates the pores, but is drawn by surface attraction between contiguous surfaces of the solid particles, forcing these particles apart, and resulting in an enlargement of volume when saturated, and a corresponding shrinkage in drying, the measure of which varies with the texture of the sand. I have found it about 4 per cent. in a rather coarse and very pure granitic quicksand, and 8 per cent. in a finer sand of similar character. It is this which gives to quicksands their fluid or *quasi* fluid character.

But while the actual storage capacity of all porous soils is substantially the same, and in all cases rather over than under 40 per cent., considering the compressibility of all — or nearly all — natural earth, the quantity which will drain out, and is therefore available for use, varies extremely with varying size of grains, particles or pebbles. From a rather coarse sand, 47 per cent. of which would not pass through a sieve with open meshes 0.053 in. diameter, and only 16 per cent. through 0.024 in. meshes,[*] a quantity of water was pumped out equal in volume to 22.3 per cent. of the total volume of the saturated sand, although the open space was, in the aggregate, 37 per cent. The balance, 14.7 per cent., equal to 40 per cent. of the contained water, was required to wet the surface of the sand grains. This sand, it is true, was well compacted, and the open space was less than in natural sand beds of equal fineness. In coarser beds, the yield is much more; in finer beds, much less. It is probable that in most beds so freely permeable as to be considered water-bearing strata, from 10 to 30 per cent. of the space may be used as storage capacity, the average being, rudely, 20 per cent. This accords with the results of a considerable number of observations of rain-fall and corresponding rise of the surface of ground-water.

An inch of rain, sinking quickly down in level, moist,

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[*] *Physical analysis of the sand above mentioned.*

No. of Grade.	Nominal number of meshes per linear inch.	Diameter of wire: by measurement. In.	Mean size of mesh passed through, including wire. In.	Mean size of open mesh passed through each way. In.	Weight in grains: 7,000 grains to one pound avoirdupois. Grains.	Ratio of each grade to the total weight. Per ct.	Specific gravity of solid particles. Sp. gr.	Ratio of full space to total space. Per ct.	Ratio of empty space to total space. Per ct.
1	50 pebbles	–	–	–	394	4.2	2.61	–	–
2	–10	–	–	–	983	10.6	2.61	57.0	43.0
3	10–12[a]	.0181	.1026	.0845	362	3.9	2.61	–	–
4	12–16	.0125	.0870	.0745	1,606	17.3	2 64	60.6	39.4
5	16–20	.0098	.0625	.0527	1,017	10.9	2.63	59 7	40 3
6	20–30	.0096	.0534	.0438	3,409	36.7	2.62	59.7	40.3
7	30–40	.0113[b]	.0352	.0239	1,021	11.0	2.61	60.3	39.7
8	40–50	.0095	.0260	.0165	190	2.0	2.61	57.7	42 3
9	50–60	.0075	.0200	.0125	47	.5	–	–	–
10	60–70	.0067	.0188	.0121	63	.7	–	–	–
11	70–	.0060	.0159	.0099	209	2.2	–	–	–
–	–	–	–	–	9,301	100.0	2.62	59.75	40.25

[a] Through 10 x 10; *not* through 12 x 12.

[b] Change from iron to brass wire.

Mean specific gravity of the porous mass, compressed, dry, = 2.62 × .5975 = 1.57.

Weight of 1 cubic foot, compressed, dry, 62.3 × 1.57 = 97.8 lbs.

Weight of water which one cubic foot will contain, 62.3 × .4025 = 25.1 lbs.

Weight of 1 cubic foot saturated with water, 97.8 + 25.1 = 122.9 lbs.

In natural sand, all sizes mixed together, the finer grains partially filling the interstices of the coarser sand, compressed, dry, the full space = 63 per cent.; empty space, = 37 per cent.

Weight of 1 cubic foot, dry, 102.80 lbs.; wet, 125.85 lbs.

This sand appears to be composed chiefly, if not entirely, of disintegrated granite, the quartz and felspar, and some hornblende, in palpable and distinguishable grains, and the mica in an impalpable powder permeable earth, will raise the surface of the water underground about 5 inches; will by so much increase the steepness of the underground water-slope towards the open drainage-channels, and in a certain degree, determined by the circumstances of each case, accelerate the underground flow.

Each subsequent shower, so long as the rain-fall exceeds the annual average, still further increases the slope, until a maximum is reached, at a level, varying with the season, from which it subsides during the drier portion of the year, as the water seeps away, to the lowest stage for the season. For a distance of eighty miles along the southerly shore of Long Island, N. Y., and for a distance of from three to fifteen miles inland, the surface of the ground is not far from level, and the texture of the soil is so nearly homogeneous that the underground water declines towards the ocean with a slope almost uniform at any particular time, but varying with the rain-fall, between the limits of two and eight feet in a mile. Streams flowing down from the interior a mile or two apart, have a surface slope of from two to eight feet per mile.

Roads, at similar intervals, are bordered by farm-houses, each supplied with water by a well, in all of which the height of the water varies with the season, as I have described, but always in strict mutual relation, so that the height of undisturbed water in one well being ascertained, the height in all neighboring wells may be known by comparison. Many cases of this kind have come within my own observation, and many more have been brought to my notice by engineers of wide experience, some of them offering very interesting peculiarities, the consideration of which would lead us too far, but all presenting the same underground flow induced by a surface slope.

Under conditions such as we are now considering, the construction of wells is a simple process. The very first one in any such locality will probably offer few unexpected difficulties, and no formidable ones; and after a few are made, others may be as accurately estimated, both as to the time and cost, as roads or ditches. The slope of the underground water may be determined with reasonable precision, and the variations of surface-level will reveal the probable depth of the well. A dry period of the year being preferably chosen, it is only necessary to sink a pit to the water, and as much lower as may be conveniently practicable, and to sustain the surrounding earth by "steening" — the word is technically accurate — of stone or brick. For a certain height at the upper end, the steening should be surrounded with good clay,* well puddled, and raised a little above the surrounding earth; but quite at the surface of the ground and for four or five feet below, there should be a foot in thickness of sand between the steening and the clay (which may judiciously be enlarged in diameter at the top to fifteen or twenty feet), to avoid danger of disturbance by frost. A well so made, is a "pit-well," and the central cavity of its lining, or steening, is the "well-pit." To the unreflecting, this well-pit may seem to be the well itself; but if a well be indeed a source of water-supply, we must give the word a wider meaning. Left undisturbed, the water within the well-pit will rise to a level with the ground-water around it. This statement needs a little qualification. Strictly speaking, the surface of the ground-water, in the conditions we are considering, is never level — nearer level after long drought than when recent and heavy rains have added to its volume — but still always sloping towards its natural drainage outlet, from two to eight feet in a mile, equal to from $\frac{1}{70}$ to $\frac{1}{18}$ of an inch in the width of a three feet well.

By one-half these quantities, then, the water in the well-pit will stand below the level of the ground-water at the up-stream side, and above it at the down-stream side, using the terms "up-stream" and "down-stream" with sole reference to the direction of the under-ground flow. Small as these quantities are, especially the former — for $\frac{1}{18}$, or even $\frac{1}{36}$ of an inch is a very appreciable fraction — such a slope as they indicate is quite sufficient to give rise to a perceptible flow through the interstices of porous natural earth, and is certainly sufficient to cause water to trickle into the well-pit from the soil on the up-stream side, and to filter out into the soil on the down-stream side.

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* Clay for puddling should be mixed with gravel, in proportions to be determined in each case by experiment.

Left to itself, the water of such a well will be slowly but constantly renewed, almost as if it were unimpeded by the sand-grains or gravel-stones of its native bed. Left still undisturbed, not much water will flow into the well-pit from a lateral direction, and none from its down-stream side. The water it will receive will come to it in a narrow stream, of width little greater than its own diameter.

Whatever soluble matters, derived from any polluting source, may come to it, must come from within the borders of that narrow stream; all else will pass by it, or flow away from it. But the instant water is drawn out of the well-pit, all this is changed. A bucket or two drawn out, may lower the surface of the free water in the well-pit an inch; sufficient, if long enough continued, to produce a level and arrest the flow away from the well, on the down-stream side, for a distance of two hundred and twenty feet at the flattest, or fifty-five at the steepest slope; and to produce a current *towards* the well from the down-stream side equal to the previous flow away from it for half these distances — one hundred and ten feet to twenty-eight feet. Taking for illustration the latter figures; that is, assuming the slope of the underground water surface to be eight feet in a mile, equal to one inch in fifty-five feet, and that water is steadily drawn out of the well so as to keep the surface of water within the well-pit one inch below the level at which it would stand if undisturbed, we shall have the current reversed and turned toward the well on the down-stream side for about twenty-eight feet; quickened in its flow toward the well, from the up-stream side, for a much greater distance, and diverted toward the well in a lateral direction for a distance of about fifty-five feet each way. Now, all the water flowing through the interstices of the soil in a stream about one hundred and ten feet wide will be diverted from its down-stream course, and concentrated at the well-pit, by the crater or cavity one inch deep in the middle and extending out fifty-five feet each way, *across* which it cannot flow by gravity — its sole impelling force. All the pollutions of the surface, from barnyards, and the refuse of human habitations, and manured fields, so far as soluble matters from these sources are carried down by the rains to and into the ground water, in this stream tributary to our well, one hundred and ten feet wide when its surface is steadily depressed one inch, and for a great and indefinite distance up stream, finds its way into the well-pit.

If the rate of pumping is increased, a lower level maintained, and a steeper slope produced, the tributary area will be proportionately enlarged, and the actual quantity of polluted water will be augmented, although not necessarily in greater proportion than the increased quantity of water, which, therefore, will not necessarily be any more impure. If largely and constantly drawn upon, so as to maintain a level two, three or four feet below the natural level of undisturbed water at that place and time, a slope will be given to the underground water, from all sides, towards the well-pit, extending hundreds of feet in radius all around, and bringing to it whatever soluble impurities may have been received by infiltration within this area. Barnyards, pigsties, cesspools, privy-vaults, sink drains, all will contribute whatever is soluble to the mixture.

Fortunately such a state of things can rarely attend the ordinary use of a well for the domestic supply of a single family, or even two or three families. A quantity no greater than three hundred or four hundred gallons per day distributed over the hours of daylight, would rarely depress the surface enough to cause a slope towards the well-pit from a greater radial distance than one hundred feet. If, therefore, care be taken to avoid all sources of contamination for a great distance in the direction from which water flows naturally, and to keep all such sources of danger one hundred feet or more away in all other directions, reasonable security may be looked for, provided the water within the well-pit is never drawn down more than a few inches below its natural level — the level to which a few hours of rest will restore it.

Several considerations of a general nature, applicable, *mutatis mutandis*, to almost all wells, are suggested by these conditions.

First: The supply of water to be obtained from a well is almost independent of the diameter of the well-pit. As a mere reservoir of open water to be immediately drawn upon, the value of the well-pit is in direct proportion to its cubic capacity below the water level; but as a source of continuous supply, it is to be measured almost wholly by the extent of territory from which water can be induced to flow towards the depressed surface of the water where drawn out, in connection with the porosity or retentiveness of the soil.

Second: In any given locality, two or more wells will yield no more water than one, since one, if freely and continuously drawn from, will lower the water in others near it; but if one hundred feet or more apart such mutual disturbance should not usually be felt in ordinary domestic use by single families.

Third: So long as water can be drawn out without disturbing the earth and sediment at the bottom, the yield can be increased by drawing out water freely, and thereby maintaining a lowered surface in the well-pit, and a wider area of convergent flow; and this quite irrespective of the relative height of the natural water level at the time.

Fourth: It is unimportant as to the quantity, how such depressed surface is maintained — whether by a bucket, or by a pump, or by one kind of pump or another; — by hand-power, horse-power, steam or windmill; a given depression of surface, resulting in a determinate slope, under established conditions, will produce a certain flow of water by its own gravity, notwithstanding the interstitial friction of the soil; and no human instrumentality exerted at the well can influence this flow in any other manner than by lowering or raising the water level in the well-pit, and thereby increasing or diminishing the slope.

Fifth: The danger of pollution — malice apart, and wind-borne dust left out of consideration — is not at the open mouth of the well, but on the permeable surface within the tributary area, a circular area of one hundred feet radius or more, and in the case of wells subject to constant and heavy draught, several hundred feet.

An open well consists of three essential parts: *First*, the shaft, leading down to the water; *second*, the well-pit extending below the surface of the water; and *third*, the surrounding porous earth, out of which water will flow by gravity alone into the well-pit whenever the surface within the latter is drawn down below the outside level, with a velocity due to the slope of the surface, in the existing conditions of interstitial friction.

This would still be true even if the surrounding water were part of a vast subterranean lake open to and continuous with the well-pit; only in such case the slope would be insensible because the friction would be only the fluid friction of open water, which is insensible to ordinary methods of observation; but in all natural soils, even the most porous, the slope necessary to produce rapid flow is very easily detected, observed and measured.

Of these three parts, the first and second must usually be provided by human agency. The third must be supplied by nature and replenished by the rains of heaven. For almost all purposes, a simple pipe or tube, sunk into the earth a few feet below the surface of the ground-water at the lowest stage from which it is to be drawn, will constitute a perfect equivalent of the open well-shaft; and the cavity which will soon be formed around the lower end of such a pipe by drawing out with the water the sand and finer pebbles mixed in the soil with coarser material, will become a substitute for a well-pit. If the water be drawn out by means of a pump attached directly to the pipe at its upper end, this sand will be found troublesome and injurious in the pump, and on that account it is customary to furnish the lower end of the pipe with a strainer of some kind, to intercept the gravel and the coarser sand. When an efficient strainer is used, which really excludes from the pipe all but the finest sand-grains, the formation of a cavity around the lower end of the pipe is greatly impeded, and the "well-pit" is reduced to a rudimental form — all that is left of it being that space within the pipe below the water level, which would be occupied by the same pipe if inserted as the suction-pipe of a pump in an open well; and even this so altered in character from a true well-pit as to be irrecognizable, inasmuch as *within* the pipe a portion of the normal weight of the atmosphere may be lifted off by the pump-piston, and some degree of "vacuum," so called, may be formed, while *without*, upon the water surface outside of the pump-pipe, the full weight of the atmosphere must always rest as in an open well-pit.

The pump, therefore, may be made to facilitate the flow of water from the outside to the inside of the pipe, provided water is already actually present at the outside, so as to wet the exterior surface and exclude air, and provided, also, other water is present to push it in and to take its place; and so on, in a continuous stream to the surface on which the atmosphere rests, whether that surface be open, as in an uncovered pit-well, or covered over with a platform, or with earth, which in all ordinary natural conditions is freely permeable to air at low velocities with extremely moderate pressures. The entrance of water into the pump-pipe from without, is necessarily attended with a depression of the water-surface immediately around the pipe; and that by a flow from a little wider circle and consequent lowering *there*, and so the influence is propagated in ever widening circles. But if the pumping is continuous, the flow must be continuous; and a uniform quantity of water continuously flowing from wider to narrower circles, must flow with a constantly increasing velocity. Now such acceleration can be produced by nothing but a constantly increasing steepness of slope.

This acceleration of water in porous soil in approaching a central depression, must not be confounded with the acceleration of falling bodies *in vacuo*, or even in the air, which offers comparatively little resistance, except, indeed, to bodies of very low specific gravity. Acceleration of water in the soil, is much less than in open air, and the velocity varies more nearly as the head, than as the square root of the head. But the curve of the surface in vertical, radial section, is convex upward, and grows continually steeper from the extreme limits of the well's influence, as the well is approached. The limit of the influence of a depressed well surface, is the point at which the lessening slope becomes too small to produce sensible flow through the interstices of the soil, and will depend, in every case, on the the amount of depression of water surface at the well, — the moving force, — and the interstitial friction of the soil — the impeding force.

It necessarily follows that the mode of putting down the pipe of a tubular well, whether by boring, or driving, or digging, or by washing out the earth from within by a current of water, is without influence upon the quantity of water obtainable at any given time and place. The condition of the earth around the pipe is equally without influence in this respect, whether it be in close contact, or separated by a wide or narrow space. Substantially the same quantity of water will be obtainable, whether the pipe be forcibly driven down all the way or inserted in a hole bored part way down, large enough to receive it freely, and driven the rest of the way, or dropped loosely into a larger pipe put down the whole distance, forming a lining, open at its lower end, but otherwise impermeable, or put as an ordinary pump-pipe into an ordinary open well. In any and in all these cases, the pump, if of suitable size, can produce by drawing out a given quantity of water in a unit of time, a certain depression of surface around the pump-pipe, substantially the same in all cases with substantially the same expenditure of force; and a convergent, radial, interstitial flow, substantially the same in all cases, will result as a secondary effect of the pumping, through the depression and attending slope.

Substantially the same: not exactly. On reaching the circumference of an open well, the water will flow thence up to wetting contact with the pump-pipe without sensible slope; but with earth filling all this space, it must have a very considerable slope to maintain its velocity, and, therefore, the tubular well surrounded by earth, whether in close contact with the pipe or not, will always require a little greater depression of the water surface, and a little greater outlay of force to obtain an equal flow — an equal yield — than will a pump in an ordinary open well.

This difference, although quite observable, is not very important, and for most purposes, and in all ordinary cases, a tubular well and an open well may be considered as substantially equivalent. The choice between them is practically limited to a question of cost and convenience. These considerations will vary with the varying character of the soil and other natural conditions, on the one hand, and with the facilities which the given locality affords for obtaining the requisite tools, materials and skill for constructing the two kinds of well, respectively. If well diggers of experience, skill, and responsibility are at hand, and ready to make an open well for a reasonable price, there can be no sufficient reason for incurring either extra trouble or extra expense to obtain a tubular well, and a similar remark is no less true in an opposite sense, under reversed conditions.

I have considered, above, it will have been observed, the conditions arising when the pump was attached directly to the upper end of the suction pipe, necessitating a strainer at the lower end of the suction pipe, to exclude from the pump entrained sand and gravel, which would injure the pump, and soon destroy it, if, indeed, they did not altogether stop its working by excessive friction. It is often better to set the pump at a little distance from the pipe, and connect it with the upper end of the pipe by a short section of horizontal pipe, with an enlarged chamber, provided with suitable deflectors, screens, and openings for removing sand and other solid materials drawn up with the water. Such an apparatus, called a "sand-chamber," is well known among the makers of tubular wells. Being above the surface of the ground, it is always accessible for clearing out and for repairs, and there need be nothing below the ground at all liable to disarrangement or rapid deterioration. By the use of such a sand-chamber, a considerable space around the lower end of the pipe, may be emptied of its finer material, and a resulting cavity may be formed, partly filled with stones too large to be pumped out, but in all essential respects equivalent to an open well-pit, considerably improving the operation of the well.

Among the various competing systems of construction, some may offer an advantage in one locality, but be surpassed in another locality by another system; but the considerations relevant to this question of comparative availibility are such as relate exclusively to the cost and convenience of construction; all are substantially alike when once completed. An excellent method is to first force a pipe into the ground as far as it can be driven without injurious violence, and then to remove the soil from the inside by means of a stream of water forced down through a smaller pipe. If the suction pipe is one and a half-inch, one and three-quarter-inch, or two-inch gas pipe, — all very suitable sizes, — the auxiliary pipe may be of three-quarter-inch gas pipe. Its lower end should have welded into it a point of solid steel of square or triangular section, and several holes one-quarter-inch or a little more in diameter should be drilled a short distance above the solid point, to let out the water. Upon the upper end of this pipe, is to be screwed a common three-quarter-inch gas pipe T, into which two short pieces of three-quarter-inch pipe — each six or seven inches long — are to be screwed, forming a transverse handle, resembling an auger-handle, one end of which is to be stopped with a cap, or coupling and plug, while the other end is left open to connect with a suitable hose to convey water into the pipe, from a hydrant or from a force-pump provided for the purpose. The steel point, forced into the earth within the pipe and turned by the handles, will loosen the soil, and facilitate its removal by the stream of water forced out of the holes near the lower end of the pipe.

This loosening and washing out process may be carried below the end of the suction pipe at the time, to a depth which will depend upon the kind of soil encountered, and this will form a cavity somewhat larger than the outside of the suction pipe, which may then be very easily driven further into the ground. In this way it is not difficult or expensive to put down suction pipes of the size I have mentioned, in ordinary sands, gravels, and clays, where no bowlders or ledges of hard rock are encountered, to a depth of more than one hundred feet.

It is hardly necessary to say that if the water sought is surface water, that is, water that has settled down into the soil from the surface on which it fell, within the adjacent natural drainage channels, such pipes as these we are now dealing with, one and a half-inch to two-inch gas pipes, cannot be sunk, advantageously, more than about thirty feet, — thirty-three or thirty-four feet at the most. Too small to admit of the insertion of a practicable pump, such tubes can only be used as the suction pipes of pumps connected with them at their upper end, either directly in continuation of them, or indirectly by means of a horizontal pipe, with or without an intervening sand-chamber.

If, as is often the case, an abundant supply of water, really surface water, in soil permeable all the way down from the top of the ground — may be reached at a depth of thirty-five, fifty, or sixty feet below the surface, a pipe of three-inch, three and a half-inch or four-inch gas pipe may be put down in the manner I have described, or in any other convenient manner, to a suitable depth below the surface of the underground water, — five or six feet below, — and after all the earth has been removed from within the pipe, together with as much as may be convenient of the finer material around its lower end, a pump-barrel, with its foot-valve or "sucker," its movable valve, or "bucket," and its suction pipe, may be inserted in the larger pipe, as in an open well dug and stoned in the usual manner.

Of course, the movable valve, or "bucket," at its highest position when in operation, must not be more than about thirty feet higher than the lowest level to which water may be depressed outside of the suction pipe by the act of pumping, and this at the lowest stage of the ground water; and it will be more convenient not to let it exceed twenty-five feet. In case the height to be lifted by "suction" is likely to be at times as much as twenty-eight to thirty feet, it will be well to put a supplementary valve — a true "fool-valve" — near the lower end of the suction pipe, as an additional safeguard against losing the water by leakage of the valves and bucket-packing. In many cases — perhaps in most cases — it will be desirable to provide the lower end of such a suction pipe with a fine strainer, of sufficient area to keep out sand without seriously obstructing the inflow of water, since in the case we are now considering an intermediate sand-chamber is not available.

So far as procuring a supply of water is concerned, it is quite immaterial whether the larger pipe, constituting a well-curb, be left in place after the pump with its suction pipe has been inserted to the proper depth, or drawn out, leaving the well unsupported to cave in around the pump and pipe, or not, according to circumstances.

For convenience of repairs when the bucket and valves become worn, the outer pipe is desirable; but in some cases it may be about as well to make a simple hole in the ground, without lining of any sort, and to put the pump and suction-pipe down into the hole. Such a construction was patented in England in the year 1823, by John Goode, a very distinguished inventor of machinery for constructing artesian wells, and also distinguished as a constructor of artesian wells, and of wells in superficial strata.

Goode's method was to make a hole of suitable size to the required depth, and "to force a pump-barrel with bucket and sucker down the hole, until the sucking-pipe entered the water;" and this method is perfectly available to-day. In most water-bearing strata, an efficient strainer will be required at the lower end of the suction-pipe. There are some existing patents, which may be valid, relating to methods of construction, and some care will be required to obtain a license from duly authorized persons; but the just measure of the license fee for the use of any such patent, is the saving effected by it in the construction of the well, and in no case can the cost of a tubular well, license fee included, justly exceed the mere cost by any one of several available unpatented methods, or methods on which, as in the case of Goode, the patent has expired, and the invention has become public property. Litigation now pending will probably settle before very long some questions relating to patents concerning which it may not be proper to say more in this place.

It will have been observed that so far we have had our attention directed exclusively to surface wells, in strata everywhere within their influence freely permeable to air and water, and substantially homogeneous, at all events in lateral extension, if of various superimposed strata. Such conditions being simple, are most favorable for the study of general principles. But although common enough, such conditions are far from universal. It not infrequently happens that surface water, in permeable strata, exists in extremely variable quantity and under very diverse conditions, in places only a short distance apart. In directing and superintending the construction of twenty or thirty open wells, all within the range of a mile or two, I have encountered many diverse conditions. Sometimes the quantity of water flowing into the well-pit gradually increased with the depth after it was first met, until it became unmanageable with the means available for keeping it out, and it was, therefore, necessary to stop where we were, and to stone up and complete the well. Sometimes, not far from such a well, water would be found in a retentive stratum of fine material, out of which it would ooze slowly, with no very sensible increase in quantity even after the well-pit had been carried to a depth of ten feet or more below the surface of the ground-water; yet by slow and constant infiltration through a large area, when the surface was drawn down, yielding an adequate supply. Again, at no great distance, after digging several feet in earth substantially dry, a vein of water running freely under ground, almost as in a rivulet upon the surface, flowed into our excavation and ran away at the same level, requiring but a slight depression to dip out of, to give a plentiful water supply continually renewed.

In this latter case, and in similar cases, some original difference in the character of the soil had long ago caused a more rapid flow through some porous streak, and the current had gradually worn away its channel, partly by mechanical erosion, and partly, perhaps, by chemical solution, and so formed an underground stream, with tributaries flowing into it, hurrying to an outlet as a spring, either in a valley or side-hill, or in the bed of a river or pond. Of course in the vicinity of such a hidden rivulet the water would be mostly drained into it, and the adjoining earth must be nearly dry. Such a stream in fact produces naturally the effect I have described in connection with the surface of water in a well-pit artificially lowered — water flows out of the surrounding soil into it by gravity, because it is lower than the surrounding water surface would otherwise be. Sometimes in circumstances differing slightly from those last described, the water of such an underground rivulet is, at the point where the well penetrates to it, locally depressed by some fold of a stratum nearly or quite impermeable, and finds an outlet at a higher level. In such case, when water is reached, it flows in rapidly and fills the excavation to a depth corresponding to the height of the natural outlet. The surface of water in the well, when once it has come to rest, is the normal height of the underground water at such time and place, from which is to be reckoned the depression produced by pumping, which will result in underground flow, radially, towards the well. These last conditions approach closely to the conditions necessary to the formation of artesian wells, and indeed sometimes shade into them by almost insensible degrees. The loose and perplexing use of the high sounding name, "Artesian Wells," for mere tubular wells — driven or otherwise — in surface strata, is to be discountenanced. Artesian wells, properly so called, can be made only where water, derived from an elevated source, often very remote, and always outside of the natural drainage channels directly about the site of such wells, is locally depressed in its path to some natural outlet, and confined by impervious over-lying strata below, sometimes far below, the level to which it would rise if not so confined. The accompanying section of the London basin, fig. I.,* so clearly indicates the conditions essential to the formation of artesian wells, that little explanation will be required. Rainfall upon the chalk stratum at its exposed margins, about Dunstable and St. Albans on the one side, and about Knockholt on the other side, sinks into the depressed portions of the same stratum, confined between the Gault clay below and the plastic clay and the London clay above, having its lowest natural drainage outlet at the point indicated by the letter C. The wells which are seen to be carried down to and into this chalk stratum at the points marked respectively D, E, F, G, H, and I, and at the Model Prison between E and F, all being so constructed as to admit water only at the lower end, are filled with water up to the level of the line A B, — the level of the lowest natural outlet, C, — unless their top be lower than said level. But, when, as at G and H, they are sunk in ground the surface of which is below the level line A B, the water will flow out above the surface of the ground. When it does not flow in this manner, it must be raised by pumping, which produces a relative depression in and immediately around the well, and as a secondary effect by means of such depression, a convergent flow towards the well. Here, as elsewhere, the weight of the atmosphere resting on the surface of the underground water at the exposed margins of the chalk, is equivalent to about thirty to

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* Copied from plate XLVI., vol. V, professional papers of the Corps of Royal Engineers, published by John Weale, London, 1842, and described on pp. 267–268, of said volume.

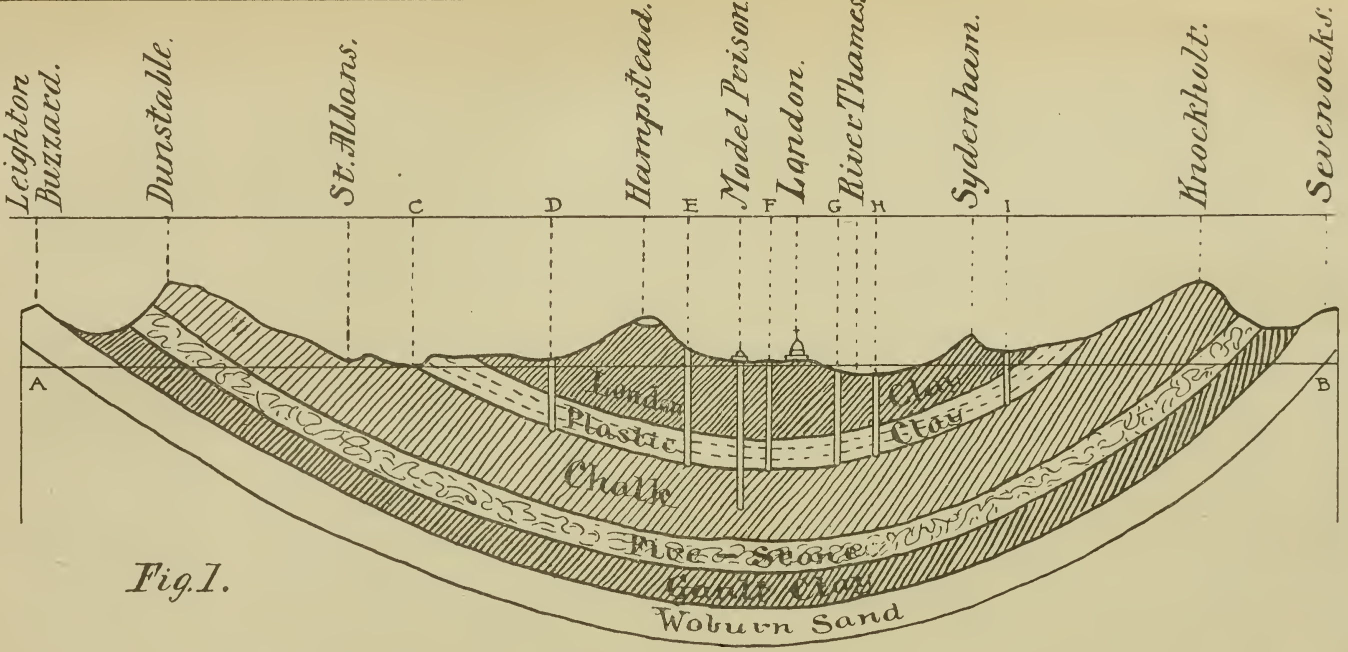

Fig. I.

Section showing the Cause of the Rise of Water in Artesian Wells in the Basin of London.

thirty-three feet of water, and the removal of any part of this weight from the water surface within a pump, results in a differential atmospheric weight, to be added, in the form of an equivalent water column, to the surface depression produced in the well by pumping. The sum, will be the motive force to overcome interstitial friction and to concentrate water at the well.

Such wells are very numerous in the London Basin, and their number is constantly increasing, and as a consequence the general level of water is depressed year by year, as much, it is said, as two feet *per annum*. Yet so vast is the reservoir formed by the immense chalk deposit, that no apprehensions are felt as to the permanence of the supply.* This interesting set of conditions which makes possible the construction of artesian wells, can rarely, if ever, have any direct application to the construction of driven wells, or ordinary tubular wells. Sometimes a shallow pond or pool, supplied by no turbid streams, and protected by groves or forests from dust, save that which is never absent from the purest air, has gathered through long periods of time from the winds that swept over its surface a slowly formed deposit so fine as to form a tenacious, impermeable bed, perhaps indurated by calcareous or ferruginous cement into "hard-pan," perhaps retaining the character of clay. Such a pond, becoming gradually filled, may be at this day a swamp, a peat-bed, or the site of glacial or alluvial drift, hiding its earlier character from view. Beneath such impermeable concave beds water derived from rain falling on the surface of the ground around their margin, may be prevented from draining away by other impervious beds lying in the way of its natural outlet. A driven well of no great depth, piercing such a concave bed of impervious clay or hard-pan, will permit the water to rise within it to the level of its natural outlet, just as an open well would also permit the same water to rise to the same height; and a depression of the water in or around the well, produced by drawing or pumping water out, will result in a convergent flow to restore the disturbed level. Such cases must be exceptional, but one of the cases I have described, within my own experience, must have had some such origin. Occasionally, true artesian wells are produced by sinking to moderate depths, not beyond the reach of driven wells. There are at Chicago several true artesian wells, not far from the shore of Lake Michigan, only from seven hundred to thirteen hundred feet in depth, from which water flows in large quantity above the surface of the ground, and rises, when the pipes are carried up so high, to a height of more than one hundred feet above the surface of the lake. This water must therefore be received from the clouds upon elevated land, yet there is said to be no land sufficiently elevated within a less distance than one hundred miles. The quantity of water is greatest when it is allowed to flow away near the surface of the ground, and diminishes steadily with increasing height until, at some height above the lake it would come to static equilibrium, and the flow would cease altogether. It is not easy to conceive the existence of conditions in permeable soil which can admit of such free and apparently unimpeded flow in obedience to hydrostatic pressure through one hundred miles of any soil. Nor is it easy to see what and where can be the natural obstruction to outflow into the lake, which causes this water to stand, when allowed to find its level more than one hundred feet higher than the surface of the lake.*

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* The vastness of this natural reservoir may be inferred by comparing the area of the chalk with the channel of the Thames, which is greatly exaggerated in the drawing to render it visible.

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* *Artesian Wells, Chicago, Illinois. Proceedings of the Common Council,* 1870–71. *Page* 56.

DESIGNATION AND LOCATION OF WELLS.	Depth, in feet.	Diameter in inches.	Quantity in U. S. gallons discharged in 24 hours, by measurement.	Quantity in U. S. gallons in 24 hours, as estimated.	Head above Lake Michigan, in feet.
Artesian well, ...	700	4	–	300,000	105
Artesian well, No. 2, . .	700	$4\frac{7}{8}$	–	400,000	105
Stock yards, ...	1,300	$5\frac{1}{4}$	–	400,000	–
Stock yards, No. 2, . . .	1,200	$5\frac{1}{4}$	–	640,000	–
Glue factory, ...	1,185	$3\frac{6}{8}$	–	600,000	107
Bridewell, ...	1,135	$4\frac{1}{2}$	500,000	–	80
Riverside, ...	700	–	198,000	–	–
County house, ...	–	–	–	80,000	–
Irving park, ...	–	–	–	80,000	–
Rolling mill, ...	1,265	$3\frac{1}{4}$	–	170,000	–
N. W. Distillery, ...	1,010	$3\frac{5}{8}$	500,000	–	100
Chicago Distillery Co., . .	–	–	80,000	–	–
Indiana St. Distillery, . .	1,310	$4\frac{1}{4}$	260,000	–	74
Lincoln park, ...	$1{,}178\frac{1}{2}$	$4\frac{1}{4}$	700,000	–	77
Mean in 24 hours, 350,571, .	–		2,238,000	2,670,000	–

These wells perfectly illustrate the principles we have found applicable to open wells and driven wells alike.

Since 1871, many additional wells have been sunk, and the quantity delivered at a given height, or the height at which a given quantity is delivered, has generally diminished. It will be observed that almost the largest quantity, estimated at 600,000 gallons in 24 hours, equal to 25,000 U. S. gallons per hour; and at quite the greatest head above the Lake, 107 feet, was delivered by the smallest well, at the Glue Factory, only 3⅝ inches diameter.

This water is highly saline, as will appear by the following analysis by Dr. J. V. Z. Blaney. The water of Lake Michigan, which is comparatively pure, is placed in the first column, for comparison. The quantities in the tables are expressed in the number of grains in a gallon of water. The well water is considered unfit for domestic use; but it is nevertheless used to a certain extent, and is said to be eagerly relished by cattle at the stock yards. It is said to corrode iron pipe rapidly, so that "it appears that from seven months to four years is as long as any iron pipe will stand in connection with this water."

Dr. J. V. Z. Blaney's Analysis of Lake and Artesian Well Water.

SUBSTANCES.	Lake Michigan.	ARTESIAN WELLS.		
		Lincoln Park.	Indiana Street.	N. W. Distillery.
Sulphuric acid,	.3024	26.233	24.5736	23 1624
Carbonic acid,	2 5043	6 248	9.6948	6 1354
Chlorine,	.2083	7.092	6.9570	5 9220
Lime,	2.4796	10.593	11.4696	5.8524
Magnesia,	.6789	5.000	4.4100	4.9770
Soda,	–	9.352	4.5720	9.0813
Sodium,	.1350	4.592	13.1760	3 8367
Silicia,	.3512	.468	.5760	.7560
Iron and alumina,	.0756	–	–	.2880
Soda, combined with organic matter,	.0053	–	–	–
Organic matter,	1.2727	–	–	–
Total,	8.0133	69.578	75.4290	*63.0112

* *Sic.* There is some error in the last column, as the partial numbers do not make up the sum, which yet agrees with the sum in the next table, which adds up correctly. [J. C. H.]

Theoretical Combination of Substances.

SUBSTANCES.	Lake Michigan.	ARTESIAN WELLS.		
		Lincoln Park.	Indiana Street.	N. West Distillery.
Sulphate of lime,	.5141	25.727	27.8530	21.4992
Sulphate of soda,	–	19.663	14.5368	18.6660
Carbonate of lime,	4.0498	–	–	–
Chloride of sodium,	.3433	11.680	11.5300	9.7587
Carbonate of soda,	–	1.539	11.6740	1.5916
Carbonate of magnesia,	1.4013	10.501	9.2592	10.4517
Silicia,	.3512	.468	.5760	.7560
Iron of alumina,	.0756	traces.	traces.	.2880
Soda, combined with organic matter,	.0053	–	-	–
Organic matter,	1.2727	–	–	–
Total,	8.0133	69.578	75.4290	63.0112
Free carbonic acid, in cubic inches,	–	8.387	6.062	6.760

[Proceedings of common council, Chicago, 1870-71, p. 55.] J. C. H.

When no water is drawn from them, and they are allowed a period of repose, the water finds its level under an equal weight of atmosphere everywhere — at the well, and at the remote source — and all flow towards the well is arrested. When, on the other hand, water is allowed to flow away at a lower level, the water-surface is depressed, and a convergent flow takes place, proportioned to the slope caused by the depressed surface. If, by means of a pump attached to the pipe, a part of the atmospheric weight be lifted off, producing the equivalent of a steeper slope, the quantity of water will be proportionately increased, precisely as if by means of a pump with its suction pipe inserted freely in the tube of the well, a quickened flow and a depressed water surface would be produced.

Indeed, the principles are of universal application — wherever water moves, horizontally, in the soil, it moves by the impelling force of gravity, against the opposing force of interstitial friction; and in given conditions of soil, its flow can be accelerated in no other way than by increasing the slope.

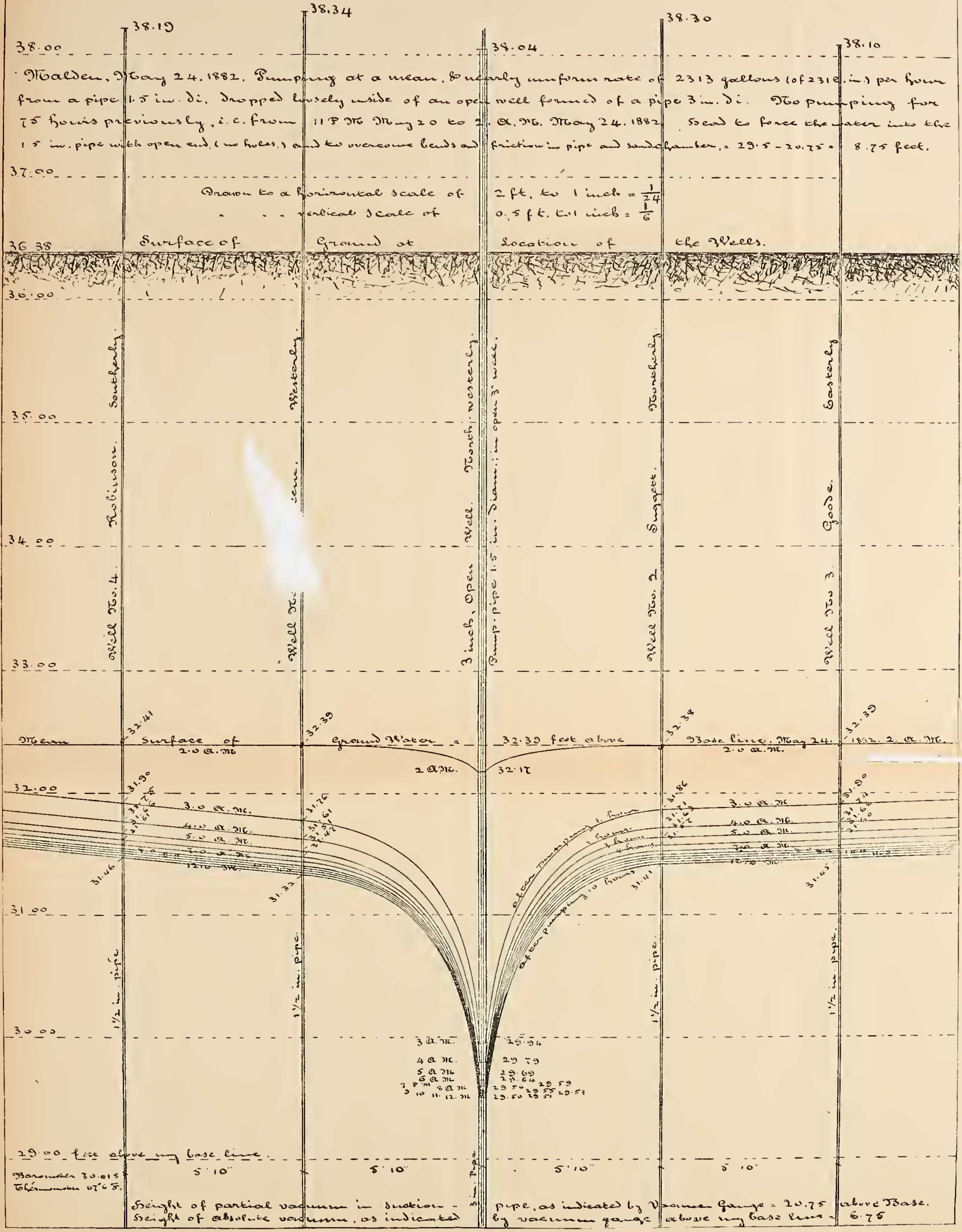
The accompanying diagram, marked "Malden Experiments," Fig. 1, embodying the results of 10 hours continuous pumping out of a tubular well composed of 3-inch gas-pipe sunk loosely into the ground about 30 feet, open at the lower end, and having no holes drilled in the lower portion of its length. The suction-pipe was of 1½-inch gas pipe, open at its lower end, and without perforations, dropped loosely into the 3-inch well-lining, and so supported as to leave the surface of water in the latter, outside of the suction-pipe, constantly exposed to the full weight of the atmosphere. A steam-pump was used, with a sand-chamber between it and the upper end of the suction-pipe; and the speed of this pump was so regulated as to deliver all the water which could flow into the chamber of the pump, keeping it completely filled, to avoid the shocks resulting from a higher speed than the water could follow.

The four wells in which measurements were taken, were located as seen on sheet "Malden Experiments," No. 4. They were all of 1½-inch gas-pipe, inserted about 30 feet in the ground, and free from soil within.

Height of valve-seat of Steam-pump, above my base = 40.80 feet.

Malden Experiments.

No. 1.



Malden, May 24. 1882. Pumping at a mean, & nearly uniform rate of 2313 gallons (of 231 c. in.) per hour from a pipe 1.5 in. di. dropped loosely inside of an open well formed of a pipe 3 in. di. No pumping for 75 hours previously, i.e. from 11 P.M. May 20 to 2. A.M. May 24. 1882. Head to force the water into the 1.5 in. pipe with open end, (no holes,) and to overcome bends and friction in pipe and sand chamber, = 29.5 − 20.75 = 8.75 feet.

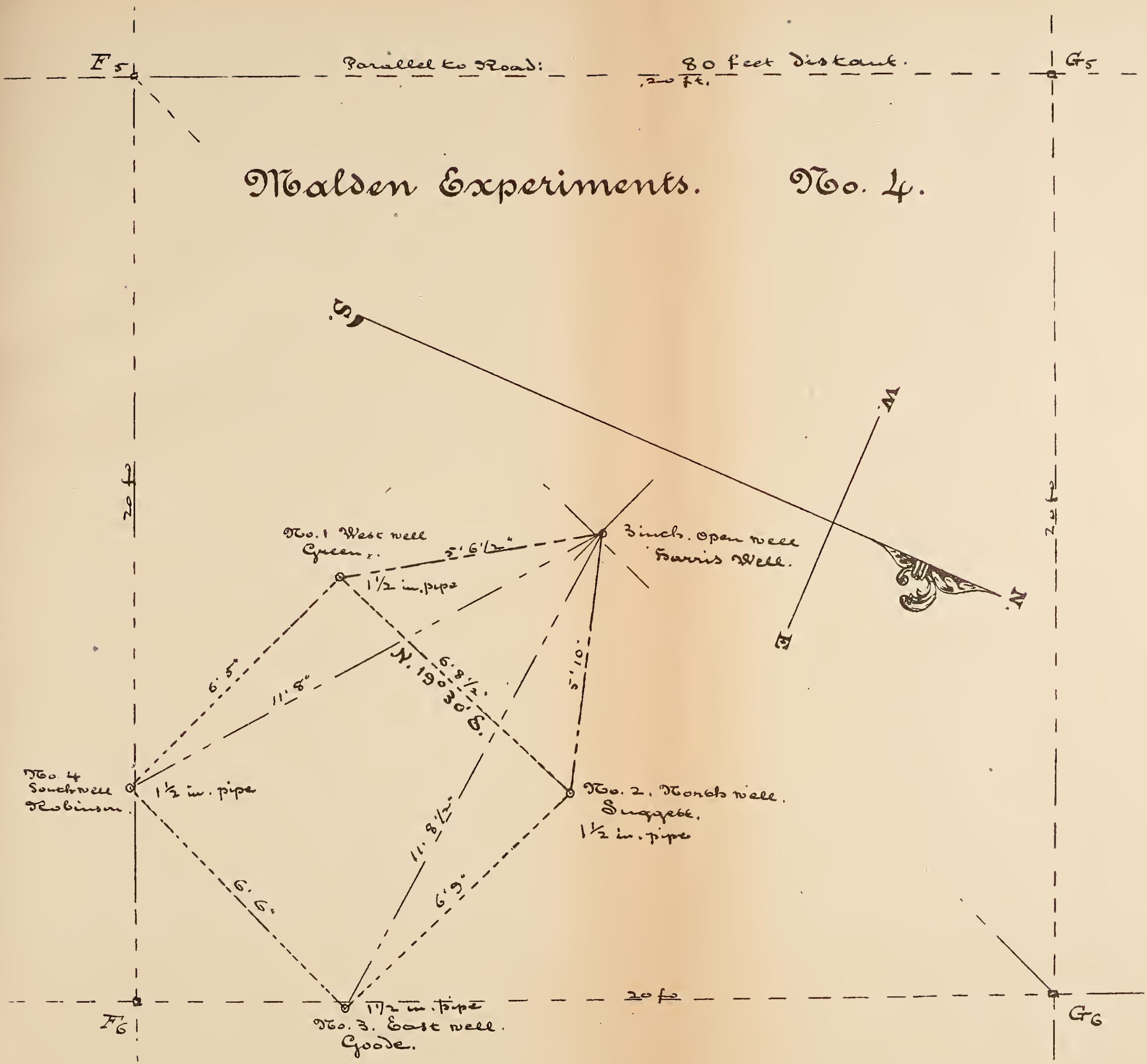
Drawn to a horizontal scale of 2 ft. to 1 inch = $\frac{1}{24}$
" " " vertical scale of 0.5 ft. to 1 inch = $\frac{1}{6}$

Mean Surface of Ground Water = 32.39 feet above Base line. May 24. 1882. 2. A.M.

Barometer 30.015
Thermometer 67°6 F.

Height of partial vacuum in suction-pipe, as indicated by Vacuum Gauge = 20.75 above Base.
Height of absolute vacuum, as indicated by vacuum gauge above my base line = 6.75

Malden Experiments. No. 4.



The slight depression at the 3-inch open well, 0.22 feet (32.39 — 32.17) at the beginning of the experiment, at 2 o'clock A. M., was caused by trying the pump just before the measurements were made for starting. The subjoined table, table I., shows in feet and decimals of a foot the measured height of the water-surface in each of the five wells above an assumed reference plane, 1st, at starting at 2 o'clock A. M., and 2d, after continuous pumping during one hour, at 3 o'clock A. M.; and also, by the differences of these two sets of heights, the amount of depression produced by pumping during this first hour, at each well.

TABLE I.

TIME.	1½ inch, No. 4.	1½ inch, No. 1.	3 inch, open well.	1½ inch, No. 2.	1½ inch, No. 3.
2 A M., ...	32.41	32.39	32.17	32.38	32.39
3 A.M., ...	31.90	31.76	29.94	31.86	31.90
Dif., ...	.51	.63	2.23	.52	.49

A slope from all directions towards the 3-inch well has now been established, just steep enough to supply the quantity of water which the suction-pipe and pump can properly discharge; but the diameter of the circle drawn upon, although large, is not large enough to supply this quantity of water continuously.

We shall therefore find, as the result of continued pumping, that the slope, although constant as to steepness, is drawn down continually lower, but with diminishing rapidity, until a regimen is attained which just supplies the demands of the pump by the natural flow of the intercepted sheet of under-ground water, after which both the steepness and the height of the slope remain constant until, indeed, rains or other causes alter the conditions. The subjoined tables show the progress of this epression of a slope of uniform steepness.

TABLE II.

Lowering of the Surface of the Ground-water after Two Hours Continuous Pumping.

TIME.	1½ inch, No. 4.	1½ inch, No. 1.	3 inch, open well.	1½ inch, No. 2.	1½ inch, No. 3.
2 A.M.,	32.41	32.39	32.17	32.38	32.39
4 A.M.,	31.75	31.61	29.79	31.71	31.74
2d dif.,	.66	.78	2.38	.67	.65
1st dif.,	.51	.63	2.23	.52	.49
3 to 4,	.15	.15	.15	.15	.16

TABLE III.

Lowering of the Surface of the Ground-water after Three Hours Continuous Pumping.

2 A.M.,	32.41	32.39	32.17	32.38	32.39
5 A.M.,	31.66	31.51	29.69	31.63	31 66
3d dif.,	.75	.88	2.48	.75	.73
2d dif.,	.66	.78	2.38	.67	.65
4 to 5,	.09	.10	.10	.08	.08

TABLE IV.

Lowering of the Surface of the Ground-water after Four Hours Continuous Pumping.

2 A.M.,	32.41	32.39	32.17	32.38	32.39
6 A.M.,	31.61	31.47	29.64	31.57	31.60
4th dif.,	.80	.92	2.53	.81	.79
3d dif.,	.75	.88	2.48	.75	.73
5 to 6,	.05	.04	.05	.06	6.0

TABLE V.

Lowering of the Surface of the Ground-water after Ten Hours Continuous Pumping.

2 A.M.,	32.41	32.39	32.17	32.38	32.39
12 M.,	31.46	31.32	29.50	31.41	31.45
5th dif.,	.95	1.07	2.67	.97	.94
4th dif.,	.80	.92	2.53	.81	.79
6 to 12,	.15	.15	.14	.16	.15

In the subjoined table (table VI.), the depression produced at each well by each hour's pumping, (brought from tables I., II., III. and IV., for the first four hours, from sheet "Malden Experiments," "No. 1," so far as relates to the central, 3-inch well, for the remaining six hours, and interpolated, in the four 1½-inch wells, for the last six hours — the interpolated figures being in italics) — may be seen at a glance.

Table VI.

Effect of Pumping Hour by Hour: Feet.

No.	Time.	1½ inch, No. 4.	1½ inch, No. 1.	3 inch, open well.	1½ inch, No. 2.	1½ inch, No. 3.
1, . . .	2 to 3	.51	.63	2.23	.52	.49
2, . . .	3 to 4	.15	.15	.15	.15	.16
3, . . .	4 to 5	.09	.10	.10	.08	.08
4, . . .	5 to 6	.05	.04	.05	.06	.06
5, . . .	6 to 7	*.05*	*.05*	.05	*.05*	*.05*
6, . . .	7 to 8	*.04*	*.04*	.03	*.04*	*.04*
7, . . .	8 to 9	*.03*	*.03*	.01	*.03*	*.03*
8, . . .	9 to 10	*.02*	*.02*	.02	*.02*	*.02*
9, . . .	10 to 11	*.01*	*.01*	.02	*.01*	*.01*
10, . . .	11 to 12	*.00*	*.00*	.01	*.01*	*.00*
	2 to 12	–	–	–	–	–
	10 hours	.95	1.07	2.67	.97	.94

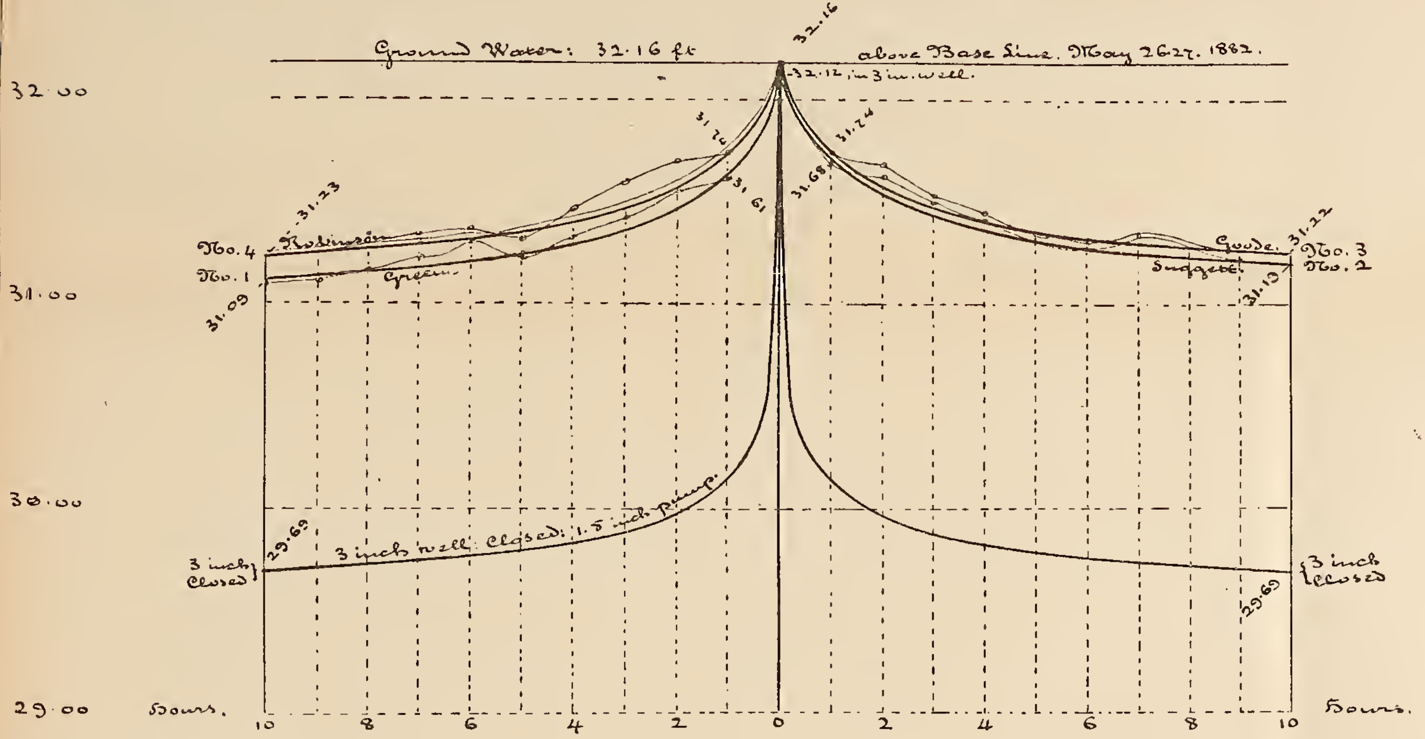
It will be seen, by studying the foregoing tables, that of the whole depression produced in the four 1½-inch wells by pumping continuously from the central 3-inch well during 10 hours, 55 per cent. was produced in the first hour; and that of the whole depression produced at the 3-inch open well by 10 hours continuous pumping from that well, 85 per cent. was produced in the first hour. Further, that as much depression was produced in all the wells during the second hour (from 3 to 4 o'clock), as during the six hours from 6 to 12 o'clock. It will also plainly appear that the first hour's pumping established a normal slope corresponding to the quantity of water delivered by the pump, which was 2,313 gallons (of 231 cubic inches) per hour, equal to 38.55 gallons per minute, and to 2.57 quarts (0.6425 gallon) per second, — the slope required in this soil to cause such a quantity of water to flow, in obedience to gravity alone convergently towards and up to the suction pipe of the pump which produced and maintained the depression *at* the well and the slope *towards* it. It is no less clear that such a normal slope, when once established, remained unchanged during the whole period of subsequent pumping, as will appear by inspection of the lower line of differences in tables II., III., IV. and V.

The progressive lowering of the slopes at each of the five wells, hour by hour as pumping went on, is clearly shown in the lower diagram on the sheet "Malden Experiments, No. 2," in which the curves for two of the 1½-inch wells, No. 2 and No. 3, are placed at the right-hand of the central axis, and the other two, No. 4 and No. 1, are placed at the left-hand of the same axis; while the single curve for the central 3-inch open well is duplicated, for symmetry, and for direct comparison with the others.

The form of these curves shows the progressive establishment of a permanent regimen, according to which the draught of water by the pump and the convergent inflow by gravity would be in equilibrium; while the parallelism of the curves, after the first hour, shows the persistence of the slope required by this rate of inflow. The difference in the steepness of the slope, radially, between well No. 2 and well No. 3, on the one hand (0.04 feet in 5.83 feet), and between well No. 1 and well No. 4, on the other hand, (0.14 feet 5.83 feet), indicates some diversity in the retentiveness of the soil about the 3-inch well. The slope above mentioned certainly did not continue unchanged outward to the limit of the inflow, but approached gradually nearer to the horizontal. The mean of the two slopes above mentioned is 0.09 feet in 5.83 feet, equal to 0.01543 feet in 1 foot horizontal. The mean of the slope outward from well No. 4 and well No. 3. to the limit of their influence, probably did not exceed one-third of this, say 0.005 feet in 1 foot horizontal, or 1 foot in 200 feet. Then, the depression being 0.95 feet at No. 4, and 0.04 feet at No. 1, say 0.945, we should have as the horizontal distance from which water was concentrated, by gravity, towards the depressed surface of water at wells No. 1 and No. 4, $\frac{0.945}{.005}$ = 185 feet, to which add the distance in a right line from each of these wells to the central 3-inch well, say about 15 feet, and we have a

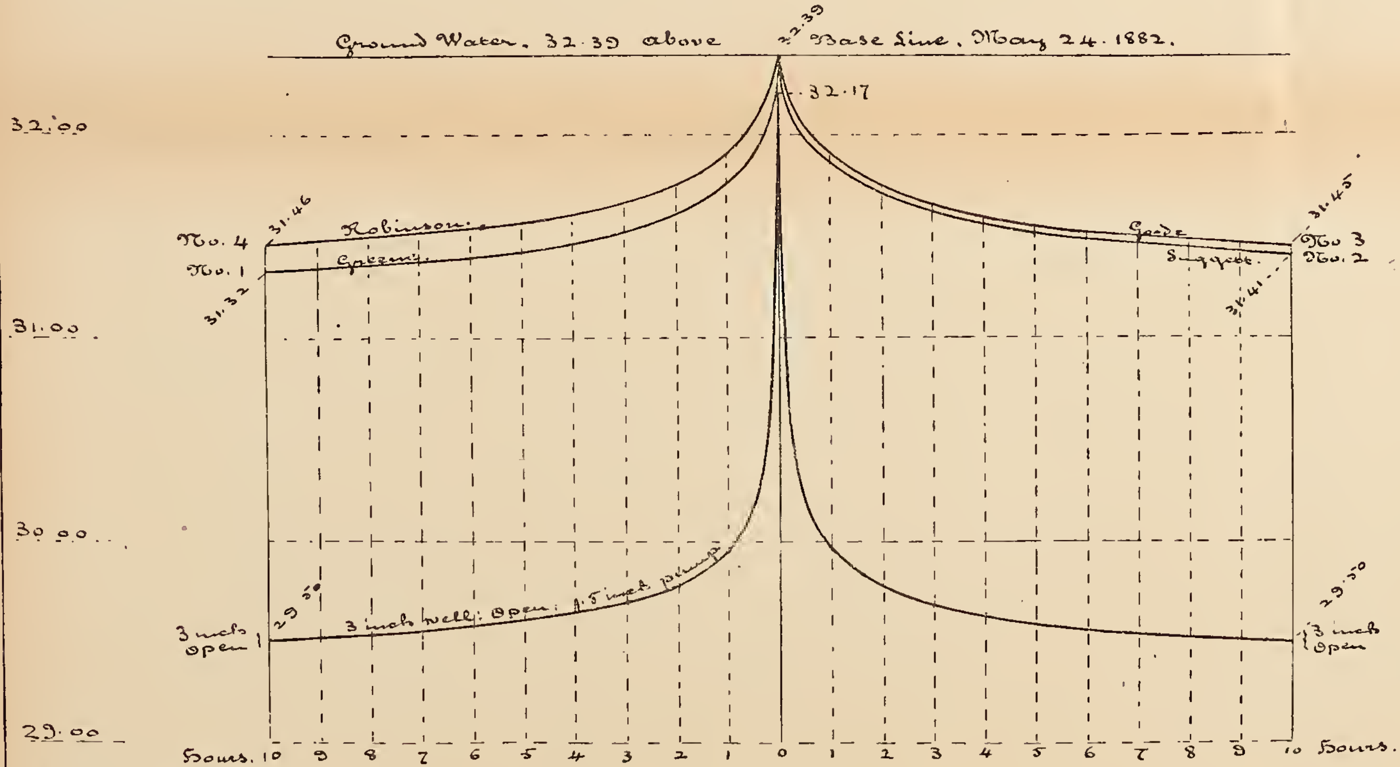
Malden Experiments. No. 2.

Malden, May 26-27. Pumping at a mean rate of 2118 Gallons per hour, (maximum = 2334, minimum = 1683 gals. per hour.) from a 1.5 inch pipe screwed into an air-tight cap screwed on top of the 3 inch pipe, which ceases to be an Open well, and becomes a Closed well. No pumping for 17 hours previously, from 3.P.M. May 25, to 9.0 A.M. May 26



Barometer = 30.009 in
Thermometer = 69°4 F

Height of vac of 8.5 lb per sq. in. = 21.16 ft. above base; Full vac. at 6.75 above base. –



Barometer = 30.015 in.
Thermometer 67°6 F

Height of partial vacuum = 20.75 above base; Full vacuum = 6 75 above base = 4080-34 05

radius of about 200 feet for the sink, or crater, into which water flowed from all sides. In the location in question, a ledge of granite rock on one side within a less distance than 200 feet, interfered with the symmetry of this crater, and its symmetry was doubtless otherwise disturbed by diversity of soil. The computation can only apply to homogeneous soil and uniform conditions. Effects altogether similar were obtained by pumping continuously for a like period of ten hours from this same central 3-inch well when fitted with a cap, closing the space at its upper end around the 1½-inch suction pipe, as will be seen upon the upper diagram of the last above mentioned sheet, "Malden Experiments, No. 2," constructed precisely in the manner already explained with reference to the lower diagram of that sheet. Some faint lines on the upper diagram show the disturbing effect of rain which fell during the ten hours of the experiment.

Pumping in turn continuously for a like period of ten hours from each one of the 1½-inch wells, in like manner presented the same results and produced effects substantially similar, the chief difference being a slight variation in the quantity of water — the largest quantity, but only a little the largest, being obtainable from the Goode well, and the next largest quantity from the 3-inch well when it was open at the top to the air.

The quantity of water obtained from the several wells respectively, when all were operated, as nearly as possible, in the same manner, is given in the subjoined table.

TABLE VII.

Yield of Water — Gallons per Hour.

No. 1. Green.	No. 2. Suggett.	No. 3 Goode.	No. 4. Robinson.	3 inch. Open.	3 inch. Closed.
1,779	2,153	2,458	2,010	2,313	2,118

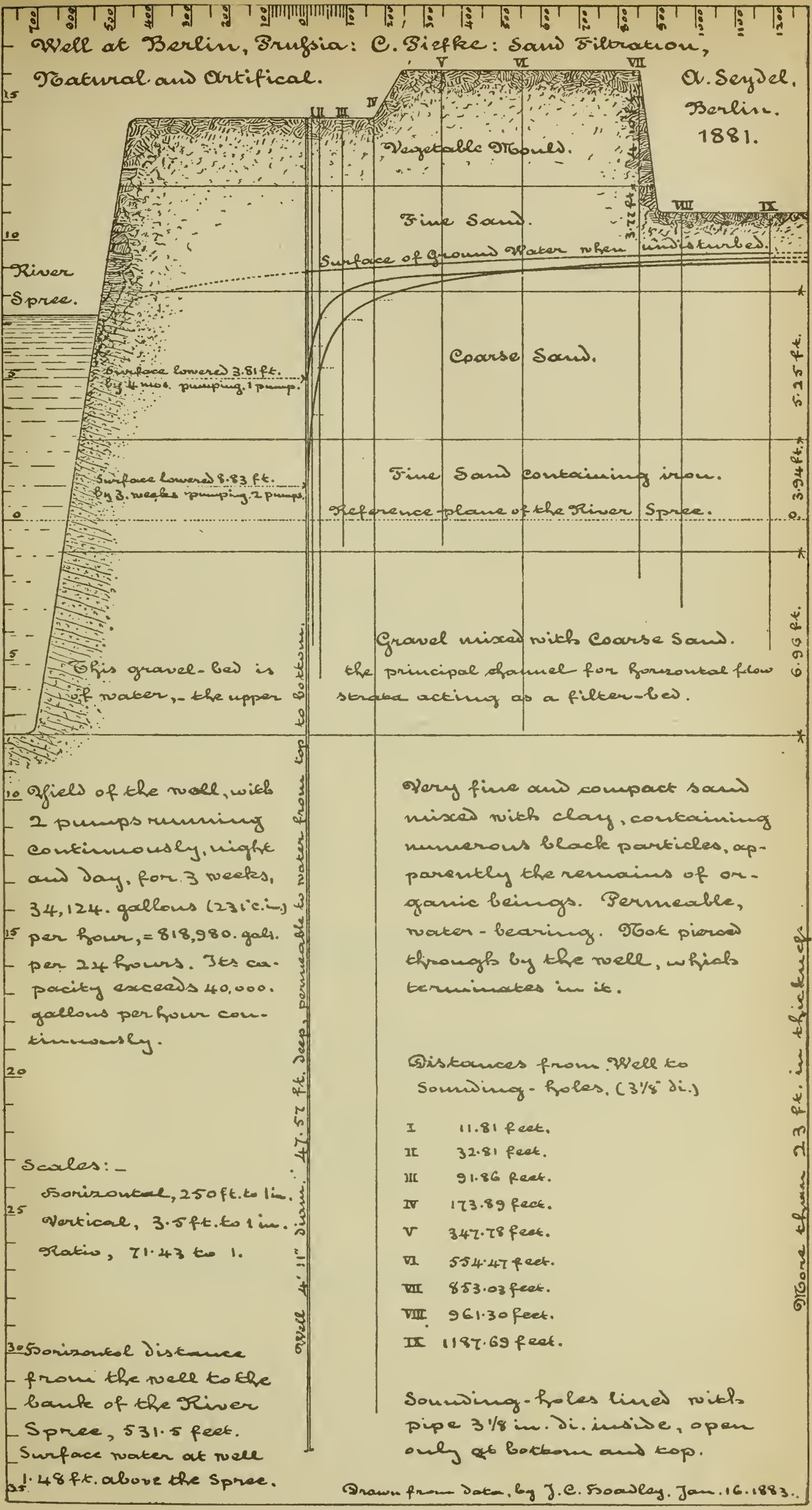
A little the most water was obtained from well No. 3 — formed of a tube of 1½-inch gas-pipe, open at the lower end, without perforations, inserted loosely in a hole prepared for it, according to the manner described and shown by John

Goode in his letters patent of Great Britain No. 4,838 of the year 1823. Taking that quantity, 2,458 gallons per hour, as a standard of comparison for all the others, and calling that 100, we have :—

Yield of the	Goode well, No. 3,	100
" "	Suggett well, No. 2,	88
" "	Robinson well, No. 4,	82
" "	Green well, No. 1,	72
" "	3-inch well, open,	94
" "	3-inch well, closed,	86

Some difference in the permeability of the soil may have caused a part of the above differences, which, after all, are too slight to lay much stress on.

The local depression and resulting convergent inflow of surrounding water produced by pumping or otherwise drawing water out of a well, and the curved contour of the water surface in radial, vertical section, convex upward, are found everywhere upon observation and careful measurement, and being in strict accordance with well-established natural laws, may be considered of universal prevalence. A striking example is seen on the sectional diagram facing p. 32 showing the effect of long-continued, uninterrupted pumping from a well at Berlin, Prussia. The capacity of this well was very large, no less than 40,000 gallons (of 231 cubic inches) having been drawn from it every hour of the day and night for months at a time. The water was used for condensing the steam of a compound steam-engine for the water-works at the Stralauer Thor, the demand requiring the use sometimes of one, sometimes of both, of two pumps set in the well. The well shaft is 4 feet 11 inches (1.5 metres) in diameter, and 47.57 feet deep, and its lining is permeable to water for its entire depth. It is located only 531.5 feet from the banks of the river Spree, into which the ground water naturally drains, with a curved slope, as indicated on the diagram by a line partly dotted, and the soil, composed of several level strata of sand and gravel, extends with great uniformity to a considerable distance from the river, certainly more than a mile. Continuous pumping during four months, with one pump only, produced a depression of the water surface of only 3.81 feet below the natural surface of ground water at the well; but the slope at 1,187.69



700
600
500
400
300
200
100
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
15
10
5
0
5
10
15
20
25
30
35
I
II
III
IV
V
VI
VII
VIII
IX
River Spree.
Vegetable Mould.
Fine Sand.
Surface of Ground Water when undisturbed.
3.77 ft.
Coarse Sand.
5.25 ft.
Fine Sand containing iron.
3.94 ft.
Reference-plane of the River Spree.
0
Gravel mixed with Coarse Sand.
6.96 ft.
Surface lowered 3.81 ft. by 4 mos. pumping, 1 pump.
Surface lowered 8.83 ft. by 3 weeks pumping, 2 pumps.
Well 4' 11" diam. 47.57 ft. deep, permeable to water from top to bottom.
More than 23 ft. in thickness.

Well at Berlin, Prussia: C. Piefke: Sand Filtration, Natural and Artifical.

A. Seydel, Berlin. 1881.

This gravel-bed is the principal channel for horizontal flow of water, – the upper strata acting as a filter-bed.

Very fine and compact sand mixed with clay, containing numerous black particles, apparently the remains of organic beings. Permeable, water-bearing. Not pierced through by the well, which terminates in it.

Yield of the well, with 2 pumps running continuously, night and day, for 3 weeks, 34,124. gallons (231 c.i.) per hour, = 818,980. gals. per 24 hours. Its capacity exceeds 40,000. gallons per hour continuously.

Distances from Well to Sounding-holes. (3⅛" di.)

I	11.81 feet.
II	32.81 feet.
III	91.86 feet.
IV	173.89 feet.
V	347.78 feet.
VI	554.47 feet.
VII	853.03 feet.
VIII	961.30 feet.
IX	1187.69 feet.

Scales: –

Horizontal, 250 ft. to 1 in.

Vertical, 3.5 ft. to 1 in.

Ratio, 71.43 to 1.

Horizontal distance from the well to the bank of the River Spree, 531.5 feet. Surface water at well 1.48 ft. above the Spree.

Sounding-holes lined with pipe 3⅛ in. di. inside, open only at bottom and top.

Drawn from data, by J. C. Hoadley. Jan. 16. 1883.

feet distance was such as to indicate a convergent flow from a distance of more than 3,000 feet. Again, continuous pumping with both pumps, during a period of only three weeks, produced a depression of 8.83 feet, but a steeper slope, a smaller depression at well IX., 1,187.69 feet distance, and a smaller radius of convergent flow, doubtless because the remote effect had not made itself fully felt in so short a time. It is obvious that all over the wide area drained by this well, all soluble substances upon the surface of the ground must be dissolved by the rains, and sink through the soil straight down to the water, and join the water under ground in its stealthy flow to and into the well.

It may be worth while to remark that all the water obtained from this well was satisfactorily proved by its physical and chemical qualities to have come by natural filtration from the superior strata, above the level of the depressed water-surface in the well; none came up from below. This is in accordance with well-established natural laws, in the absence of conditions favoring the construction of artesian wells. Another well at Berlin, connected also with the city water-works, yields a still larger quantity of water, and draws its supply from a tributary area of 5,000 metres (3.1 miles) radius, embracing 30 square miles.

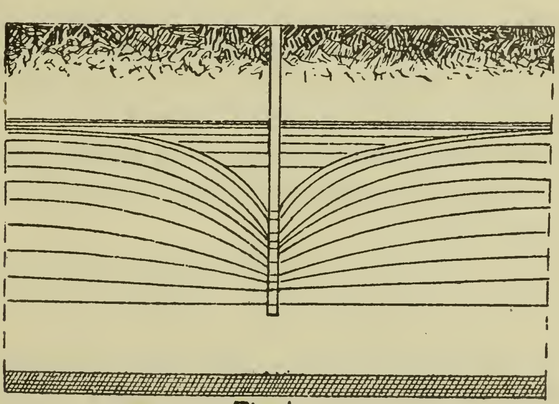


Fig. I

Figure I. illustrates the convergent flow towards a well on a vertical section at right angles to the general direction of the underground flow. As usual, the vertical scale is greatly exaggerated, relatively to the horizontal scale, for the sake of clearness. This exaggeration is necessary in order to render conspicuous at a glance relations which on the natural scale can be determined only by close observation and careful measurement. The hatching near the top, indicates the surface of the ground. The shaded space at the bottom indicates an impermeable stratum. The level lines indicate the natural position of undisturbed ground-water; the curved lines show the effect of a convergent flow towards the depressed surface of water in a well from which water is continuously drawn.

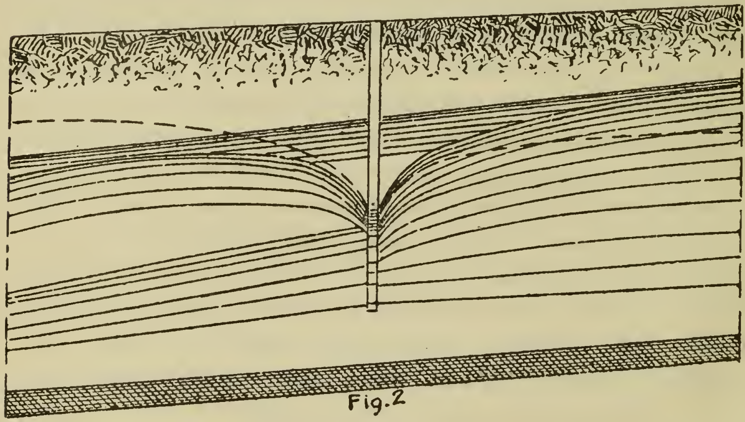


Fig. 2

Figure II., in like manner, indicates the condition of things seen in fig. I., but on a vertical plane parallel to the general direction of the underground water, and therefore at right angles with the course of the plane of fig. I.

It is obvious that the water below the lowered surface in the well, on the down-stream side, must flow away from the well, as seen in fig. II.

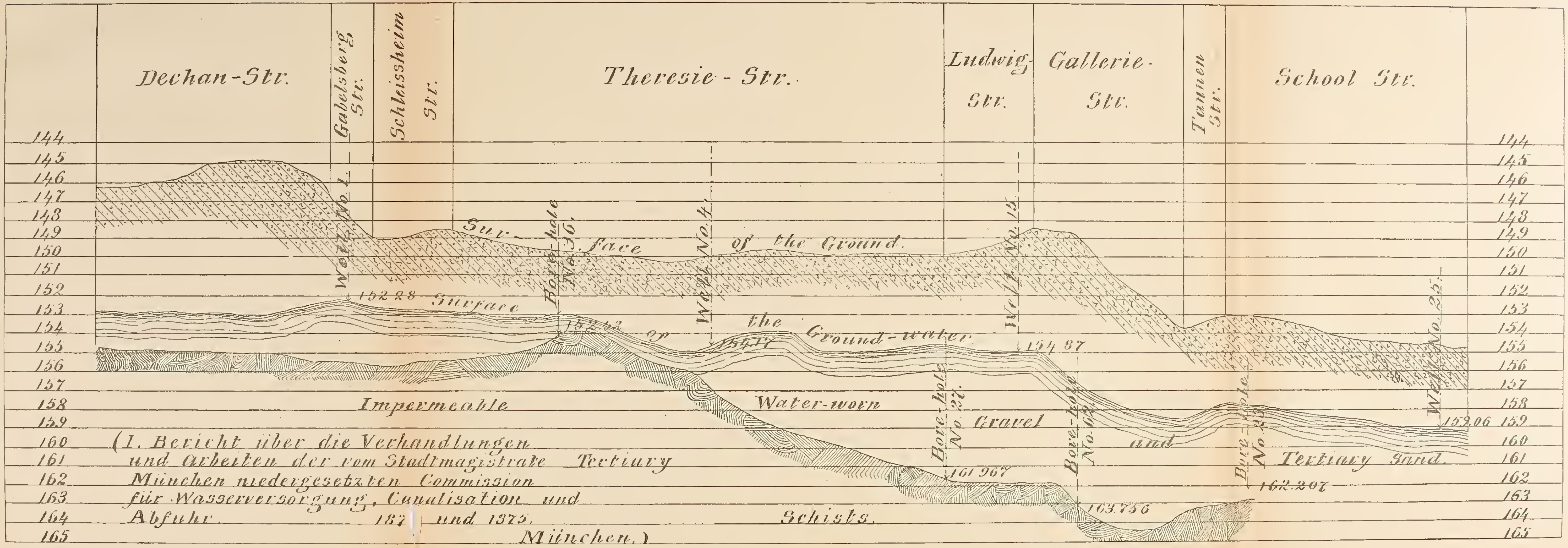
Figure III. illustrates an occurrence not very uncommon, —two strata of some impermeable material, clay, shale, or hard rock—with permeable strata—sand or gravel—overlying each and producing two subterranean streams, quite independent as far as the dividing septum extends. A well sunk into the upper water-bearing stratum only, will produce by pumping an effect shown in the upper part of fig. III. Driven through the upper impermeable stratum and not into the water of the lower water-bearing stratum, it would, if its walls were permeable, drain water away

Profile

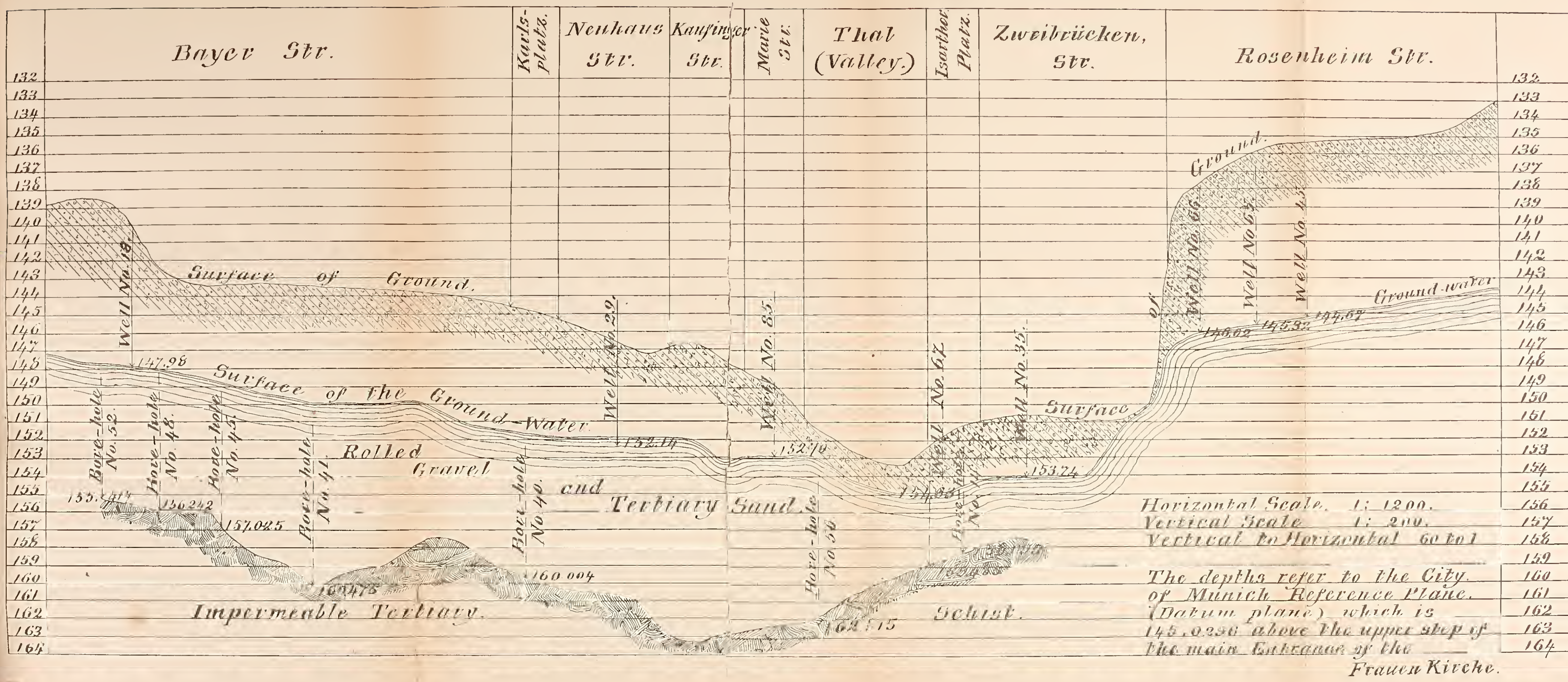
Of the Elevation of the Impermeable Tertiary Schists. And the Ground-water level, Middle of Aug. 1875.

Direction. Northwest-East.

Fig. IV.



Middle of August, 1875. – Direction. West – East. Fig. V.



Horizontal Scale. 1: 1200.
Vertical Scale 1: 200.
Vertical to Horizontal 60 to 1

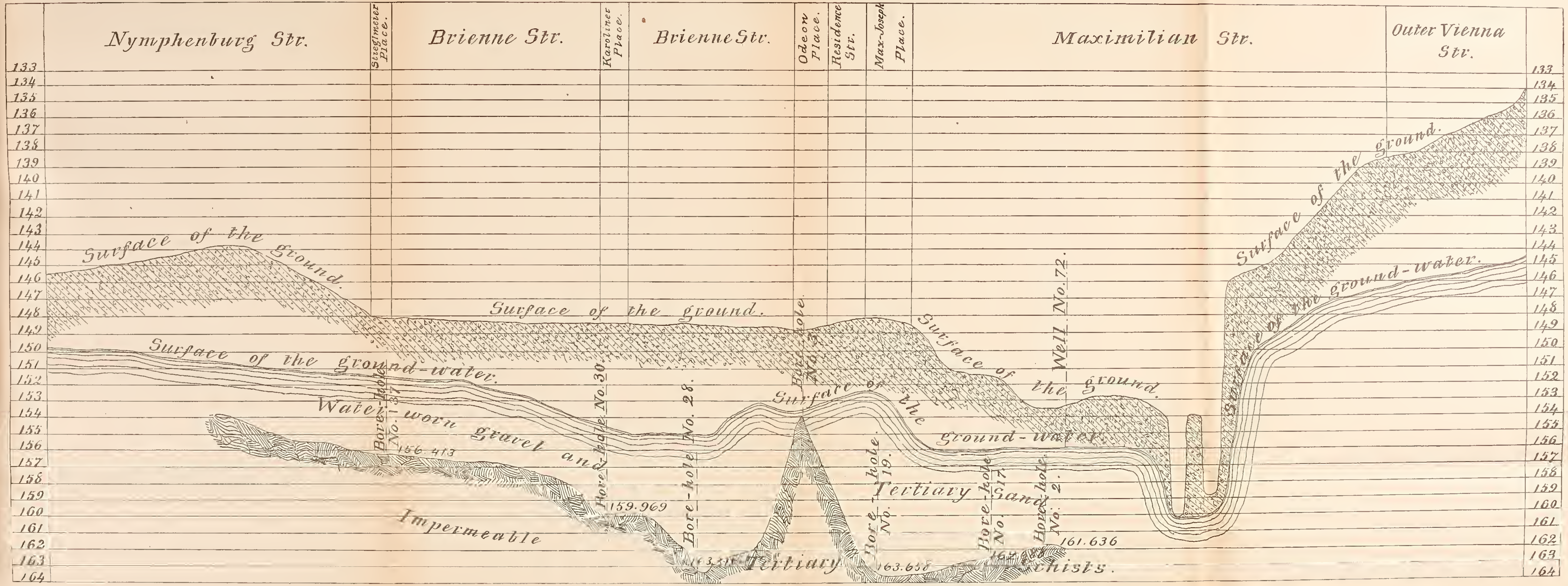
The depths refer to the City of Munich Reference Plane. (Datum plane) which is 145.0250 above the upper step of the main Entrance of the Frauen Kirche.

Profile.

Of the Elevation of the impermeable tertiary Schists And the Ground-water level, Middle of August, 1875.

Direction, North-west, South-east.

Fig. VI.



Middle of August – 1875 — Direction, West-South-east. Fig. VII.

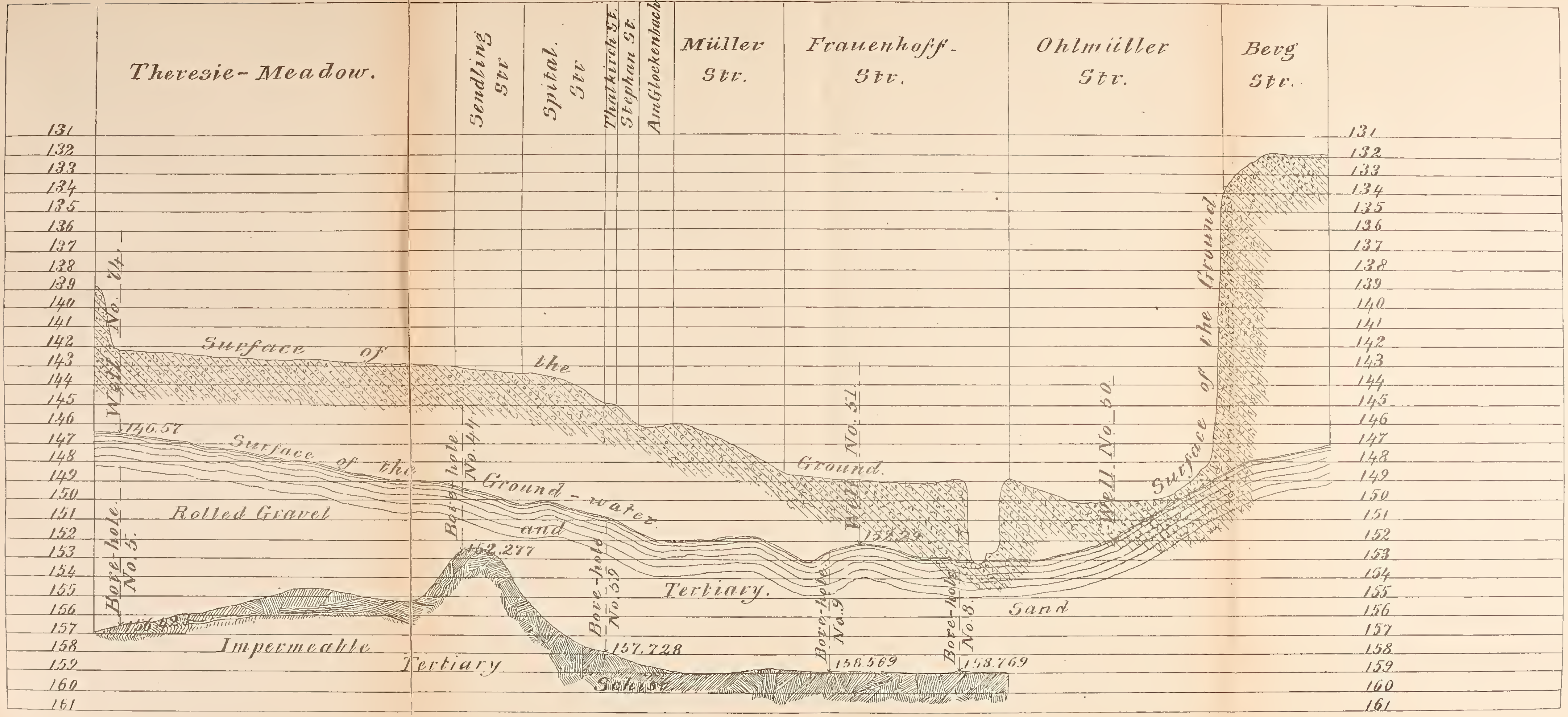
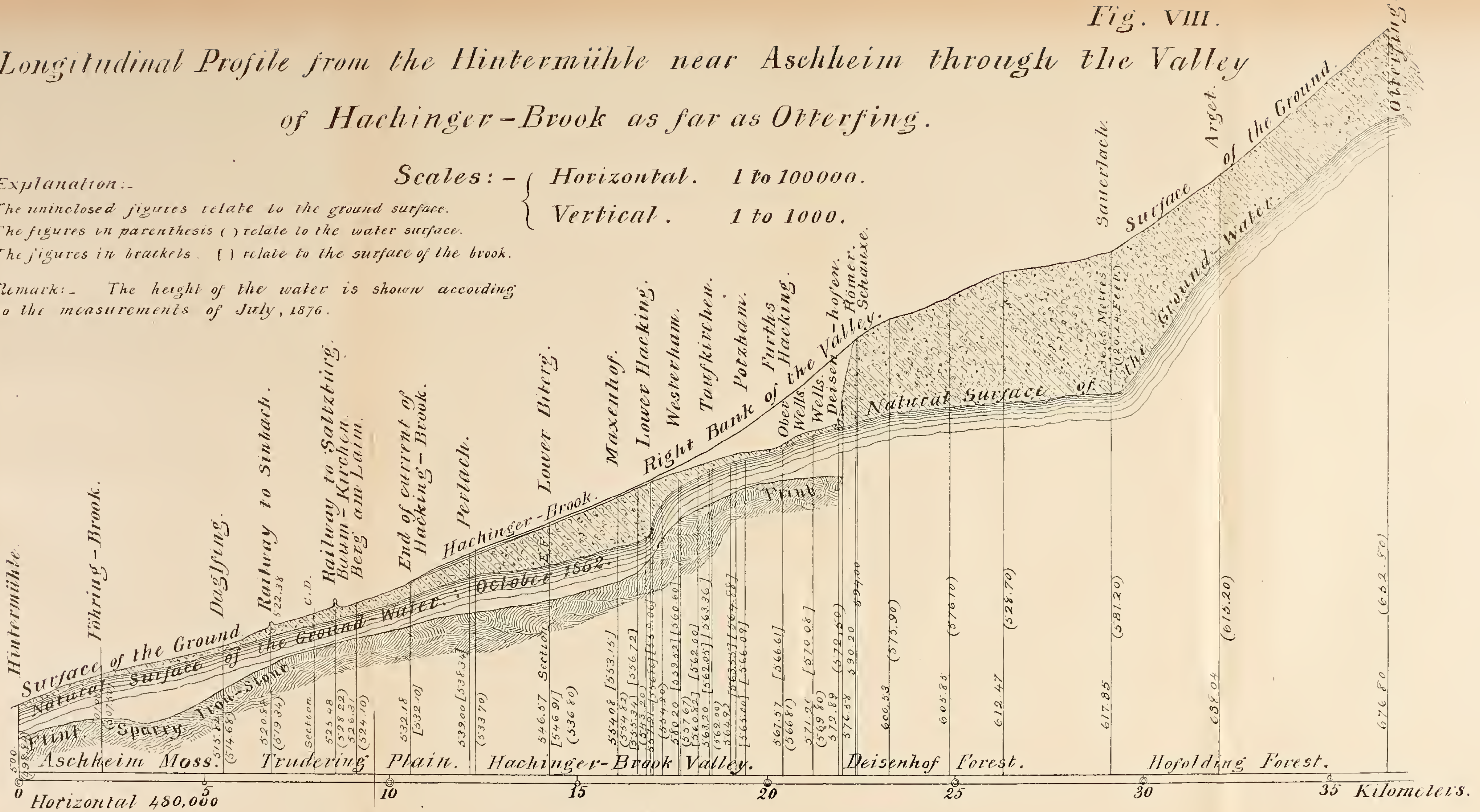


Fig. VIII.

Longitudinal Profile from the Hintermühle near Aschheim through the Valley of Hachinger-Brook as far as Otterfing.



Explanation:-
The uninclosed figures relate to the ground surface.
The figures in parenthesis ( ) relate to the water surface.
The figures in brackets [ ] relate to the surface of the brook.

Remark:- The height of the water is shown according to the measurements of July, 1876.

Scales:-
Horizontal. 1 to 100000.
Vertical. 1 to 1000.

Wasserversorgung der Stadt Munchen. A. Thiem.

from the upper stream into the stream below. Sunk into the lower water-bearing stratum and impermeable all the way up to the top, it would produce by pumping the inflow indicated in the lower part of fig III.

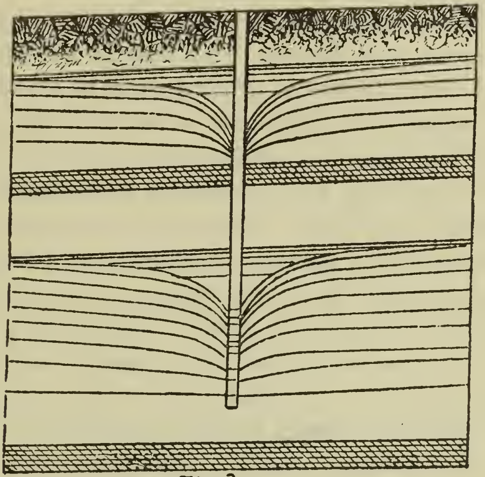


Fig. 3

Figures IV., V., VI., VII. and VIII. show the mutual relations of the upper surface of the ground, the surface of the ground-water, and the upper surface of the underlying impermeable strata, over a large area in the city of Munich, Bavaria, by actual determination, in the month of August of the year 1875. In some places the water flows quite near the surface of the ground; in other places, at a great depth below the surface. It stands in deep pools in parts of the impenetrable strata beneath it, and flows in a thin sheet over other parts, as over a weir — notably at bore-hole No. 3, fig. VI., and at bore-hole No. 36, fig. IV. Sometimes it must find an outlet in some direction other than that of the section-plane. The water at bore-hole No. 28, fig. VI., cannot reach the channel divided by an island at the right-hand, by direct flow in the direction of this section-plane, but must flow into it at some point farther down-stream; and other like cases will be noticed.

Figure VIII. illustrates the case often met, of shallow wells near the summit of a hill, and much deeper wells in lower ground at no great distance. Near the summit of

Corey's Hill, in Brookline, there is an unfailing well in which the water stands only ten or twelve feet below the surface of a gentle slope. Only a few rods distant there is a well on ground 200 feet lower, in which the water stands thirty-five to forty feet below the surface of a plain.

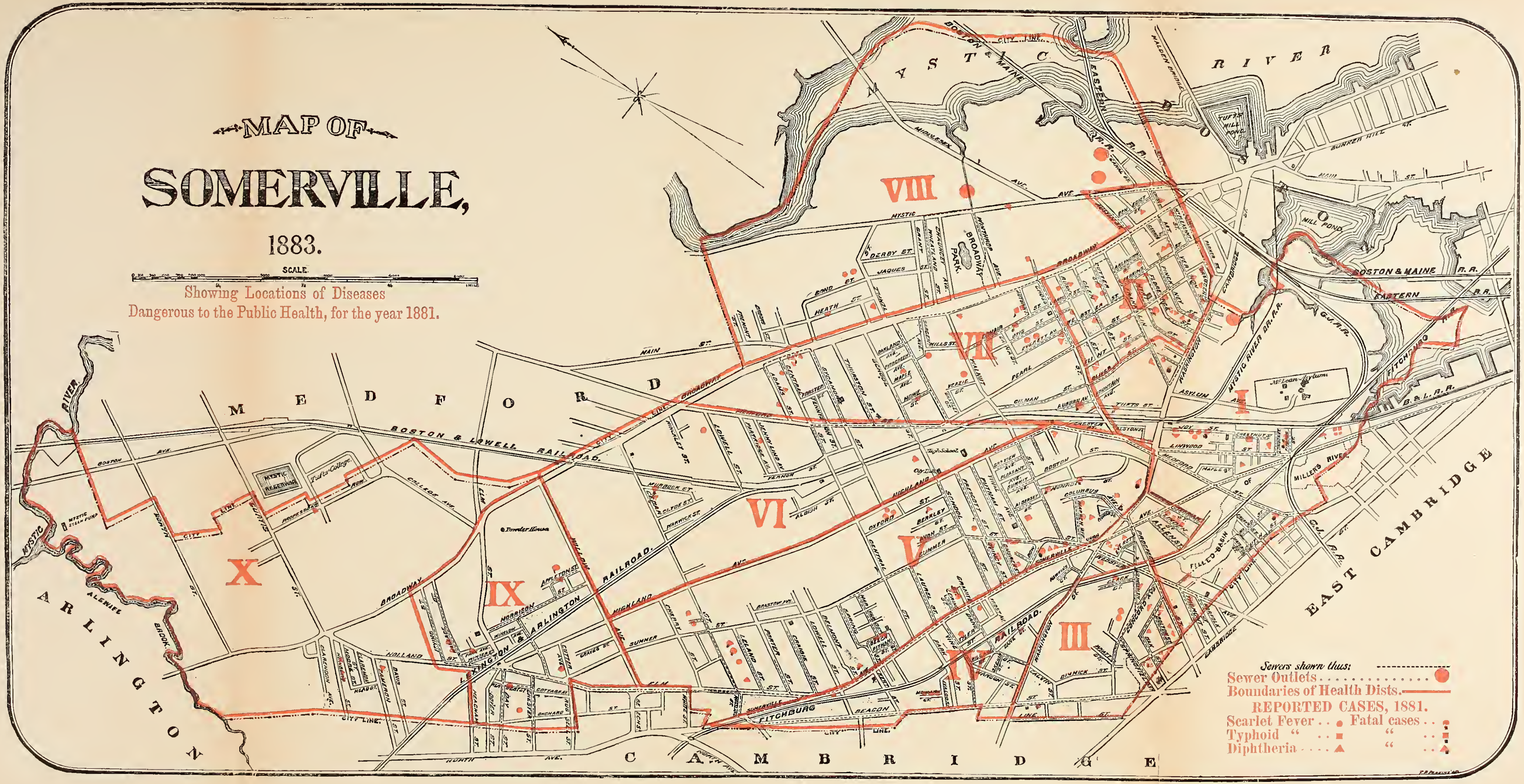
The conditions under which water exists in the ground are endlessly varied and diverse. No simple classification can embrace all cases, unless so general as to be of little value; but all are subject to a single law — the law of gravitation — the sole moving force of subterranean waters, and all are subject to a retarding force, constant in character, but extremely varied in intensity — the force of interstitial friction. All the phenomena of springs, subterranean streams, wide, diffused underground flow, and wells of every kind depend on the resultant of these two forces. Experience and common sense, with some special knowledge of each locality, will usually enable a well-sinker to obtain a satisfactory well, by adapting his means to the requirements of the case, with reasonable certainty and at a cost susceptible of calculation to a reasonable degree of approximation, in advance. The silly superstition of the divining rod, which shares with ancient astrology and modern spiritism, the invincible credulity of a certain class of minds, is generally harmless, as there is no *less* likelihood of finding water where the witch-hazel points (!) than elsewhere.

When it is considered that water is an almost universal solvent, and that the earth, alike upon its surface and in its depths, abounds in soluble substances, many of them deleterious, it appears remarkable that well-water is not, in general, more polluted than it is found to be.

But it is impossible to impress too strongly the importance of keeping at a great distance from every well used for domestic purposes, every source of contamination.

THE SANITARY CONDITION OF SOMERVILLE.

By JOHN F. COUCH, M.D.



MAP OF

SOMERVILLE,

1883.

Showing Locations of Diseases Dangerous to the Public Health, for the year 1881.

Sewers shown thus:

Sewer Outlets . . . . ●

Boundaries of Health Dists. ——

REPORTED CASES, 1881.

Scarlet Fever . . ● Fatal cases . . ●

Typhoid " . . ■ " . . ■

Diphtheria . . . . ▲ " . . ▲

THE SANITARY CONDITION OF SOMERVILLE.

The act providing for the organization of local boards of health was accepted by the voters of Somerville in November, 1877. On the 22d of January, 1878, Mayor Geo. A. Bruce appointed, and the board of aldermen confirmed, Messrs. Chas. W. Sawyer and Geo. A. Kimball members of the board of health. These gentlemen, with Dr. Emory L. White, the city physician, constituted the first board of health. It was organized by the election of Chas. W. Sawyer as chairman. Geo. I. Vincent was appointed clerk and William H. Brine sanitary inspector. I propose in this paper to briefly review the work performed by the board in the first five years of its existence. Reference will be made to the character of the nuisances dealt with, to the main features of the districts into which the city has been divided, to the relative prevalence of contagious diseases in each district, and to the number of nuisances abated in each district. The main part of the work of the board during its existence was the abatement of nuisances, the regulation of offensive trades, the making and enforcing rules tending to arrest the spread of contagious diseases, the supervision of the collection of ashes and house offal and removal of night-soil, and the issuing of licenses to keep swine and goats, and to collect grease.

The general character of the nuisances reported to the board is as follows: cellars damp; cesspools defective, overflowing; drains stopped up, not trapped, or not properly covered; filth on premises; manure exposed; offal thrown in street; slaughter-house and surroundings filthy; slops thrown in court or street; stagnant water on land or under house; vaults full or improperly constructed; water-closets not supplied with water, &c.

As there is but one sanitary inspector employed by the board it is evident that many nuisances continue unabated.

The rule requiring physicians to report cases of contagious disease enables the board to acquire a knowledge of the condition of the houses in which such cases are found. On receipt of a postal from a physician announcing the prevalence of a contagious disease, the inspector is sent at once to make a careful inspection of the house and its surroundings. The result of his examination is entered on the books.

Weekly meetings are held by the board throughout the year, and sometimes in midsummer two or three meetings a week have been held. The sanitary inspector is always present at these meetings, and makes a report on the condition of nuisances already under observation, stating how much, if anything, has been done toward their abatement. The owners of houses in which sanitary defects have been found are notified to that effect, and from week to week they are followed up, each notice sent being more urgent than the preceding. Notice *number one* is sent to the owner of the property, and if at the next meeting of the board the inspector reports unfavorably on the condition of the premises, notice *number two* is sent.

[No. 1.]

Office of the Board of Health,
Somerville, January 1st, 1880.

Sir: — You are hereby notified that your premises on Washington Street are not in conformity with the laws relating to the public health, by reason of the following: —

Drain pipe broken in cellar; water-closet in cellar not properly trapped.

We trust that you will give this matter your early attention, and by so doing save yourself any further trouble or annoyance.

Respectfully,

...., *Clerk.*

[No. 2.]

Office of the Board of Health,
Somerville, January 8th, 1880.

Sir: — You are hereby notified that your premises on Washington Street are not in conformity with the laws relating to the public health, by reason of the following: —

Drain pipe broken in cellar; water-closet in cellar not properly trapped.

You are hereby requested to put said premises in a proper sanitary condition within five days.

Respectfully,

...., *Clerk.*

A week later, if it has been found that nothing has been done, notice *number three* is sent.

[No. 3.]

OFFICE OF THE BOARD OF HEALTH,
SOMERVILLE, January 15th, 1880.

DEAR SIR: — Unless premises No. .... Washington Street are put in a proper sanitary condition within five days, this board will feel compelled to order them vacated.

Very respectfully,

...., *Clerk.*

At the end of another week, if nothing has been done by the owner of the property, the board makes a visit of inspection to the house, and after an examination has notice *number four* served on the occupant of the house.

[No. 4.]

OFFICE OF THE BOARD OF HEALTH,
SOMERVILLE, January 22d, 1880.

SIR: — The board of health, being satisfied, upon due examination, that premises No. .... Washington Street, occupied by you as a dwelling-place, have become, by reason of [naming sanitary defects], unfit for such purpose, and a cause of nuisance and sickness to the occupants and the public, hereby issues its notice to you requiring you to quit said premises within ten days from the date of service of this notice, in obedience to Chap. 26 of the Gen. Statutes.

...., *Clerk.*

To ....

On the premises.

MIDDLESEX, SS. SOMERVILLE, ...188 .

I this day served a notice, of which the above is a true copy, on the above named .... by leaving the same.

...., *Constable.*

If it be found at the end of ten days that the house has not been vacated, or that the sanitary defects have not been remedied, the chief of police is ordered to vacate the premises, and at the same time notice *number five* is sent to the owner.

[No. 5.]

Office of Board of Health,
Somerville, Mass., February 2d, 1880.

Dear Sir: — Your premises, No. .... Washington Street, having become unfit for habitation by reason of [defects specified], we have caused the said premises to be vacated; and you are hereby ordered not to permit them to be occupied again without permission from this board.

Yours, respectfully,

....
Clerk of the Board of Health.

Generally but little attention is paid to the notices until the receipt by the tenant of the notice requiring him to vacate the premises. The owner now realizes that he is about to lose a valuable tenant, and at once proceeds to put his house in a proper condition for habitation. It will be seen that the first notice was sent January 1st and the last on February 2d. Five visits were made by the inspector, and one by the full board.

During the year 1878 thirty-three tenements were ordered to be vacated, of which number twenty-one were put in proper condition before the enforcement of the order, ten were vacated voluntarily, and two were vacated by the chief of police.

Offensive Trades.

Rendering establishments were for many years prior to the organization of the board a source of great annoyance to the inhabitants of Somerville. At most of these places putrid grease was rendered in open kettles, and when it is stated that but one was supplied with proper apparatus for the destruction of obnoxious gases, it will readily be believed that they were great nuisances. The exact number of persons engaged in the rendering business at the time the board was organized is not known, but as the Boston board of health in 1877 issued licenses to collect grease to fifty-two residents of Somerville, it is fair to assume that many people were engaged in the business in 1878. In April and May, 1878, the board paid a visit of inspection to these places, and as a result of their examination passed the following order: —

Office of the Board of Health, City Hall,
Somerville, May 31, 1878.

By virtue of the authority given in chapter 26 of the General Statutes, the board of health of the city of Somerville hereby forbids the exercise, on or after June 15, 1878, of the trade or employment of rendering tallow (other than fresh tallow), lard, grease, fat, bones, or other refuse animal matter, within the limits of the city of Somerville, except at the factories of Charles H. North & Co., Medford Street, Joseph Boynton, Windsor Street, Charles O'Neil, Linden Street, or at such other place or places as may hereafter be assigned by said board; such trade or employment being in the opinion of the board a nuisance, hurtful to the inhabitants, the exercise of which is attended by noisome and injurious odors.

George I. Vincent, *Clerk.*

In the same month the Boston board of health and the Somerville board passed orders that non-residents should not be licensed without a recommendation from the city or town in which they resided. As a result it was observed that a better supervision of these parties could be had than formerly. In June, 1878, the pork packing and rendering establishment of Chas. H. North and Co. was burned. On visiting the ruins, it was noticed that very offensive odors came from the large numbers of carcasses of swine which were found in the ruins. Their speedy removal by order of the board, and the liberal use of charcoal, abated the nuisance. When, later in the season, the work of clearing the ruins was commenced, the workmen deposited a large quantity of the débris upon an adjacent lot. This material contained a large quantity of putrid grease, and when exposed to the sun was the source of much annoyance to the residents in that section of the city. By order of the board it was covered with earth and thoroughly disinfected.

Privies.

Offensive privies were the cause of many complaints. As many parts of the city were not provided with sewers, privies were regarded in the light of necessary evils, and the nuisances caused by their imperfect construction, by their close proximity to dwellings, and by their general filthy condition, were the cause of much trouble to the board. Some directions for the building and proper care of privies were issued by the board, together with the suggestion that they be discontinued and water-closets substituted where sewer-connection could be obtained. Stagnant water on land was the source of annoyance to the residents in many parts of the city. Many of these ponds were receptacles for dead animals and garbage. In dealing with these cases much difficulty was experienced, as in many instances there was no possibility of connecting with sewers, and the owners of the property objected to being put to the expense of filling in the lots. In the majority of cases, however, the orders of the board were attended to.

STABLES.

An examination of the stables in many parts of the city convinced the board that in general they were not in a satisfactory condition. Many of them were built without making any provision for drainage, and without proper receptacles for manure. In many cases the manure was found in heaps close to dwellings. Aside from an order for the prompt removal of the manure heaps, and suggestions as to the manner of securing proper drainage, and the building of receptacles for the manure, but little was done in these cases.

DANGEROUS DISEASES.

The board early recognized the importance of being informed of the prevalence of contagious diseases, and on the 27th of February sent the following notice to all physicians known to practise in Somerville.

OFFICE OF THE BOARD OF HEALTH, CITY HALL,
SOMERVILLE, February 27, 1878.

You are hereby notified that the board of health considers small-pox, diphtheria, scarlet fever, and typhoid fever diseases within the meaning of chapter 26 of the General Statutes, and that physicians will be expected to report all cases coming under their notice within the city. Respectfully,

GEORGE I. VINCENT, *Clerk.*

EXTRACT FROM CHAP. 26 OF THE GENERAL STATUTES.

"SECT. 48. When a physician knows that any person whom he is called to visit is infected with small-pox, or any other disease dangerous to the public health, he shall immediately give notice thereof to the selectmen or board of health of the town; and if he refuses or neglects to give such notice, he shall forfeit for each offence a sum not less than fifty nor more than one hundred dollars."

This notice was published in both weekly papers, and physicians were supplied with postal cards bearing a blank form of report. Owing to the prevalence of scarlet fever, and a belief that the disease was spread by children from infected houses attending school, the following notice was published, and copies sent to the principals of the public schools.

OFFICE OF THE BOARD OF HEALTH,
SOMERVILLE, October 17, 1878.

Whereas, scarlet fever is a disease contagious and dangerous to the public health, and, whereas, it is now prevalent in the city of Somerville; therefore the board of health issues the following notice: That on and after Oct. 17, 1878, the following provisions of chapter 26 of the General Statutes will be strictly enforced:

"SECT. 47. When a householder knows that a person within his family is taken sick . . . of any disease dangerous to the public health, he shall immediately give notice thereof to the . . . board of health in the town in which he dwells. If he refuses or neglects to give such notice, he shall forfeit a sum not exceeding one hundred dollars.

"SECT. 48. When a physician knows that any person whom he is called to visit is infected with . . . any disease dangerous to the public health, he shall immediately give notice thereof to the . . . board of health of the town, and if he refuses or neglects to give such notice he shall forfeit for each offence a sum not less than fifty, nor more than one hundred dollars."

And it is hereby ordered that no child from any house in which a case of this disease has occurred, or shall hereafter occur, shall, without a written permit from this board, attend any school in this city, until the expiration of four weeks from the commencement of the last case in such house; such length of time shall be certified in writing by a physician or some responsible member of the family, the certificate to be presented to the teacher of the school, before the child is admitted.

Attest: GEO. I. VINCENT, *Clerk.*

On the 23d of October the board issued a circular which contained much valuable information on the subject of scarlet fever. The nature of the disease, the period of incubation, the various ways in which it has been spread, the necessity of isolating the sick, the proper method of using disinfectants, the time at which the sick might safely mingle with the other members of the family, and when the well children might attend school, and the method of fumigating the room occupied by the patient, were the matters specially referred to. The board suggested that in case of death the body should not be removed from the room until it had been sealed in the coffin, and that funerals should be as private as possible. Three thousand of these circulars were distributed, and copies sent to every house in which it was known that there was a case of scarlet fever.

A tabulated statement of the nuisances abated in each district in 1878 is appended.

Table of Nuisances abated in each district in 1878.

CAUSE OF NUISANCE.	I.	II.	III.	IV.	V.	VI.	VII.	VII.	IX.	X.	Total.
Cellar damp, ...	3	3	2	–	7	–	2	1	1	–	19
Cesspool defective, . . .	–	–	–	–	1	–	–	–	–	1	2
" full, ...	–	1	1	1	1	–	1	–	4	2	11
" in cellar offensive, .	–	1	–	–	–	–	–	–	–	–	1
" not properly covered,	1	–	1	1	2	2	–	1	3	2	13
" under house offensive,	1	–	–	–	–	–	–	–	–	–	1
" offensive, . . .	–	–	–	1	–	–	–	–	1	–	2
Drain stopped up, . . .	–	–	–	–	1	–	–	–	–	–	1
not trapped, . . .	2	1	1	1	3	–	4	1	3	1	17
not properly covered, .	–	–	–	–	1	–	–	–	–	–	1
pipe broken and leaking,	–	4	1	–	1	–	–	1	–	–	7
Drainage defective, . . .	56	25	4	45	29	15	12	6	10	9	211
" emptying into ditch,	–	–	–	1	1	–	–	–	4	–	6
" emptying on surface,	5	–	1	6	1	4	–	–	2	1	20
Earth-closets defective and offensive, ...	–	–	–	–	2	–	–	–	–	–	2
Filth at tide gate across Alewife Brook, ...	–	–	–	–	–	–	–	–	–	1	1
Filth on premises, . . .	15	3	–	4	8	–	5	1	1	1	38
Garbage on premises, . .	–	–	–	–	3	–	–	–	–	–	3
Manure exposed, . . .	8	2	2	4	2	1	2	1	2	–	24
Offal thrown in street, . .	–	1	–	–	–	–	–	–	–	–	1
" " on land, . .	1	2	–	–	–	–	–	–	–	1	4
Offensive material carted through streets, . . .	1	–	–	–	–	–	–	–	–	–	1
Offensive odor from putrid meat, ...	1	–	–	–	–	–	–	–	–	–	1
Offensive pig pen, . . .	1	–	–	–	–	–	2	–	–	1	4
Polluting natural water-course,	–	–	–	1	15	–	–	–	4	–	20
Slaughter-house and surroundings filthy, ...	–	–	–	–	–	–	–	–	–	4	4
Slops thrown in court, . .	–	–	–	1	–	–	–	–	–	–	1
" " in street, . .	–	1	–	–	–	–	–	–	–	–	1
" " in yard, . .	1	–	–	2	–	1	–	–	–	–	4
Stable drainage defective, .	–	–	–	–	–	–	–	–	1	–	1
" filthy, ...	–	2	–	3	–	–	3	–	1	1	10
" offensive, ...	1	1	–	–	–	–	2	–	–	–	4
Stagnant water in house cellar,	1	–	–	–	1	–	–	–	–	–	2
" " in stable cellar,	–	–	–	–	1	–	–	–	–	–	1
" " on land, . .	11	1	–	14	2	6	–	–	–	–	34
" " under house, .	1	–	–	–	1	–	–	–	–	–	2
" " under stable, .	1	–	–	–	–	–	–	–	–	–	1
Vault full, ...	66	16	7	30	26	14	13	4	4	2	182
Vault not properly constructed,	12	3	–	4	–	2	1	–	4	2	28
" " " covered, .	2	–	–	–	1	5	–	–	1	–	9
" " " ventilated, .	1	–	–	5	–	1	–	–	–	–	7
Vault offensive, ...	9	3	–	5	2	5	2	–	5	1	32
Ventilation imperfect and insufficient, ...	–	1	–	–	–	–	–	–	–	–	1
Waste-pipes defective, . .	1	–	–	1	1	–	–	–	–	–	3
" not trapped, .	5	5	1	1	6	–	2	3	2	–	25
" stopped up, .	–	–	–	1	–	–	–	–	–	–	1
Water-closet defective, . .	–	2	–	–	1	–	–	–	2	1	6
" not supplied with water, . .	–	1	–	–	–	–	–	–	1	–	2
Water from cellar flowing into well, ...	–	1	–	–	–	–	–	–	–	–	1
Total, ...	207	80	21	132	120	56	51	19	56	31	773

WATER-SUPPLY.

In 1879, the second year of its existence, the board continued the work begun in 1878. The condition of the water-supply engaged the attention of the board early in the year. Complaints of impurities in the water were frequently made, and on the 19th of June a letter was sent to the Boston Water Board, a copy of which, with the reply, is appended: —

OFFICE OF THE BOARD OF HEALTH, CITY HALL,
SOMERVILLE, MASS., June 19, 1879.

Boston Water Board:

GENTLEMEN, — We have recently had several complaints of impurities in the Mystic water, and we have personally found the water at different times to be discolored.

Will you please inform us whether or not the drainage from all the tanneries and other manufactories situated within the limits of the Mystic "water-shed" has been turned into the new Mystic Valley sewer? Will you also please inform us what is the proper method of caring for our distribution pipes so as to prevent the accumulation of impurities in them? and oblige

Yours respectfully,

THE BOARD OF HEALTH OF SOMERVILLE,

By GEORGE I. VINCENT, *Clerk.*

CITY OF BOSTON.

BOSTON WATER BOARD OFFICE,
CITY HALL, June 30, 1879.

To the Board of Health of Somerville:

GENTLEMEN, — Your communication of the 19th inst. was received, and we have to reply to your inquiries as follows: —

First. The following proprietors of tanneries have entered their drainage into the sewer: Alex'r Moseley, Eustis Cummings, James Houston, Francis L. White, Bryant & King, and Lewis Shaw.

Second. If the water contains impurities, we know of no way to prevent them from going into the pipes.

The usual method of cleaning pipes when the water becomes discolored, as it sometimes does more or less, is by flushing out the pipes with the "blow-off" into the sewers, or else, as is the case with the pipes in your city, where there is no regular system of "blow-offs," it is necessary to use the hydrants for that purpose.

In regard to the present condition of the water of Mystic Lake, we have to say that our superintendent reports that he never saw it looking better or clearer than it does to-day.

Very respectfully,
BOSTON WATER BOARD,
By W. E. SWAN, *Clerk.*

During the month of July the residents of the city became alarmed at the appearance in the water of large quantities of greenish vegetable matter, and their fears were not allayed by rumors of the prevalence of sickness due to the use, for drinking purposes, of Mystic water. The writer, who at that time was city physician and a member of the board, judging from his own practice, was not inclined to put much faith in these rumors. Desiring to learn the actual condition of things, and, if possible, allay the fears of the people, it was decided to invite all physicians who were known to practise in Somerville to a meeting in the City Hall. From twelve to fifteen attended, and in the opinion of all but two, there was not an unusual prevalence of gastro-intestinal affections. Immediately after the meeting the board issued the following circular to the people: —

OFFICE OF BOARD OF HEALTH, CITY HALL,
SOMERVILLE, MASS., July 23, 1879.

To the Consumers of Mystic Water in Somerville:

At a meeting of this board with a large number of the leading physicians of Somerville and vicinity, held this day, it was voted unanimously that, while the present impurities in the Mystic water are not considered poisonous, and there is not an unusual prevalence of diarrhœal diseases in our city, yet, in order to avoid the possibility of sickness which might be caused thereby, and in view of the fact that we are just approaching the season (August and September) when diarrhœal affections are much more likely to prevail, the following precautions are suggested in the use of Mystic water, which may become more harmful as the season advances: —

First. Strain or filter the water. The simplest way to do this is by the use of a flannel or cotton-flannel bag. All strainers and filters should be changed or cleansed frequently.

Second. Boiling the water would be an additional precaution.

The board would take this opportunity to make the further suggestion, that people should be cautious in resorting to *the use of old and perhaps long-disused wells*, and also wells in locations where the water may be contaminated by drainage or otherwise. Ice water should ALWAYS be used sparingly.

Per order of the Board of Health,

GEORGE I. VINCENT, *Clerk.*

During the following week the board made a visit of inspection to Woburn and Winchester, and made a careful examination of the methods of disposing of the drainage of those towns. Most of the sewage from dwellings, tanneries and manufactories in those towns found its way into the lake, thereby contaminating the water-supply. July 29th a communication was addressed to the city council setting forth the facts and naming those firms which were polluting the water-supply, and requesting the city to apply to the State Board of Health, Lunacy and Charity to take the necessary action in the premises. The city council passed the order requesting the mayor to make application to the State Board of Health, Lunacy and Charity to take such action as was deemed necessary. At the time our application was presented a similar one was received from the Boston Water Board. August 8th a hearing was given to the interested parties. The State Board voted to visit both Woburn and Winchester and make an examination of the premises. The following day an agreement was entered into between the owners of tanneries and the Boston Water Board, in which the former promised to cease draining into the lake, and, as a result, the State Board deferred further action.

During the year, 1,197 nuisances were abated; referred to board of 1880, 148, making a total of 1,345 cases investigated. Thirty tenements were ordered to be vacated as unfit for habitation. Of these twenty-six were put in proper sanitary condition. During the year nineteen privies were abandoned by order of the board.

In 1880, the third year of its existence, the board had very little beyond routine work to attend to. The Alewife Brook nuisance continued to annoy the residents of that section of the city, but beyond calling upon the Cambridge authorities to abate it nothing was done. Early in the summer the residents of East Somerville were very much alarmed by a nuisance caused by the filling of the Mill Pond in the Charlestown District of Boston. By the filling of the pond the channel for the sewage from the East Somerville district was closed, and the marshes and flats in that part of the city overflowed with sewage. With the aid of the Boston Board of Health a culvert was built under the Mystic River branch of the Lowell Railroad at a cost of sixteen hundred dollars, one-half of which was paid by each city, and the nuisance was abated.

The prevalence of small-pox in many parts of the State induced the board to make some provision for preventing its advent into the city, and in the month of November the city physician was directed to procure vaccine virus and be prepared to vaccinate, free of charge, those who called upon him for that purpose. In the month of December the board adopted the following regulations for the construction of house drainage: —

In Board of Health of the City of Somerville,
Dec. 9, 1880.

By virtue of the authority given to boards of health, by chapter 133 of the Acts of the General Court for the year 1877, the Board of Health of the city of Somerville hereby makes the following regulations for the construction of house drainage: —

Section 1. *Materials.* — That portion of the house drain which is outside of the building, and more than four feet from the foundation walls, shall be constructed of iron pipe, or the best quality of drain-pipe.

That portion of the house drain inside or under the building, and also that portion outside the building and within four feet of the foundation walls, together with the soil-pipe, shall be constructed of iron pipe with leaded joints.

The waste-pipes connecting with the conductors from the roofs, and all other pipes inside the building or outside and within four feet of the foundation walls, shall be constructed of lead or iron with leaded joints.

Sect. 2. *Grades.* — The house drain and other pipes for the conveyance of sewage shall be laid with a uniform grade, and a fall of not less than one inch in four feet, except in cases where the city engineer may permit otherwise.

SECT. 3. *Traps.* — The house drain shall be provided with a trap which shall be located outside of all house connections.

Every pipe connecting a water-closet with a soil-pipe shall be trapped close to the connection with the water-closet.

All waste-pipes shall be trapped, each separately, and close to the connection with the bath, sink, bowl, or other fixture.

SECT. 4. *Ventilation.* — All soil-pipes shall be carried at their full size through the roof, and left open. A provision shall also be made for admitting air to the house drain on the house side of the main trap.

SECT. 5. *Workmanship.* — The joints in the drain-pipe shall be carefully cemented under and around the pipe, and the joints in the iron pipe shall be run and calked with lead.

All changes in direction shall be made with curved pipes, and all connections shall be made with Y branch pipes.

All joints and pipes shall be made air-tight.

The whole work to be executed by skilful mechanics, in a thorough and workmanlike manner, and satisfactory to the Board of Health.

SECT. 6. *Plans.* — Before proceeding to construct any portion of the drainage system of a hotel, tenement, or dwelling-house, the owner, builder, or person constructing the same shall file with the city engineer a plan thereof, showing the whole drainage system, from its connection with the common sewer to its terminus in the house, together with the location of all branches, traps, ventilating pipes, and fixtures.

SECT. 7. These regulations shall apply to all hotels, tenements, dwelling-houses, and other buildings hereafter erected in the city of Somerville.

Continuing to receive complaints of stables, and aware that but little care was taken in the removal of manure, the following regulations were adopted and published: —

IN BOARD OF HEALTH OF THE CITY OF SOMERVILLE,
Dec. 9, 1880.

Ordered, That the owners or occupants of livery or other stables within the city of Somerville shall not wash or clean carriages, or horses, or cause them to be washed or cleaned in the streets or public ways; they shall keep their stables and stable-yards clean, and no manure shall be allowed to accumulate or remain uncovered outside of the stable building.

No person shall remove any manure, or cause or suffer the same to be removed, between the first day of May and the first day of

November, except between twelve o'clock at night and two hours after sunrise, without a written permit from the Board of Health.

No manure shall be removed or carried through the streets of this city, except in a tight, canvas-covered vehicle, with the covering so secured to the sides and ends of the vehicle as to prevent the manure in process of removal from being dropped or left in any street or way of the city. No manure shall be loaded into a vehicle in or upon any street, lane, or passageway, nor upon or across any sidewalk.

The total number of nuisances investigated during the year was 857; number abated, 730. Twenty tenements were ordered to be vacated, and of these seventeen were put in a satisfactory condition. During the year eighteen privies were abandoned and water-closets substituted.

In 1881 nothing of special interest occurred. There being no material change in the condition of Alewife Brook, and having come to the conclusion that no voluntary movement toward its purification would be made by the authorities of Cambridge, it was decided to petition the State legislature for relief. Accordingly, on the 25th of January a communication was sent to the legislature in which, after referring to the filthy condition of the brook, the board prayed for such legislation as would prevent any further contamination of the brook. On the 6th of May, 1881, a bill was passed which provided for the disposal of the sewage, which otherwise would pass through the brook. The bill, not being acceptable to the citizens of Somerville, was rejected by the city council. This brook receives the contents of three main sewers which drain an area of over eight hundred acres, and a hog-slaughtering establishment, a tannery and three currying shops. The bill provided for the disposal of this sewage through one of Somerville's sewers, and in return Somerville was to receive $1,000 a year.

During the year 1,186 nuisances were investigated, of which number 1,108 were abated. Thirty-eight houses were ordered to be vacated, thirty-five of which were put in a proper sanitary condition. Thirty-two privies were discontinued during the year.

In 1882 1,045 nuisances were investigated; number abated, 945. Forty-eight houses were ordered to be

No. of Family.	Nationality.	Occupation of Head of Family.	No. of Patients.	Sex of Patient.	Age of Patient.	Date of Sickness.	Result.	District.	Soil.	Locality.	House Drainage.	Condition of Cellar.	Privy.	Remarks.
1	Irish,	Laborer,	1	Female,	6	January,	Fatal,	5	Clayey Gravel,	Fair,	Drainage on surface; waste pipe not trapped,	Damp,	8 feet from house.	
2	German,	“	2	Male,	5	“	. . .	1	Clay,	“	“ “ “ “	No cellar,	12 feet from house; full,	Premises filthy.
			3	Female,	4	“								
			4	Male,	1¼	“	Fatal,							
3	American,	Salesman	5	Female,	1	“	“	5	“	“	Waste pipe not trapped; water-closet offensive,	Damp,	Water-closet in cellar,	Offal from three families under L of house.
4	Irish,	Laborer,	6	“	9	“	. . .	3	“	“	“ “ “ “	Dry,	20 feet from house.	
			7	Male,	7	“								
5	“	Machinist,	8	“	2	“	Fatal,	3	“	Low,	Drainage defective; water-closet defective,	. . .	Water-closet in cellar.	
			9	Female,	6 mos.	April,	“							
6	American,	Laborer,	10	Male,	2	January,	“	6	Clayey Gravel,	Fair,	Water-closet offensive and defective; w. p. not trapped,	Damp,	“ “	Offensive odor in kitchen from sink.
7	“	“	11	“	7	“	. . .	5	Clay,	“	Waste pipe not trapped,	Dry,	“ “	
8	“	Clerk,	12	Female,	5	“	. . .	7	“	Good,	Drainage defective; waste pipe not trapped,	No cellar,	Water-closet in basement.	
9	Irish,	Laborer,	13	Male,	11	“	. . .	1	Clayey Gravel,	Low,	Opening in drain pipe in cellar,	. . .	12 feet from house,	Offensive odor in cellar.
10	“	Junk Collector,	14	“	7	“	Fatal,	1	Clay,	Fair.	Waste pipe not trapped,	No cellar,	20 “ “	Mother of this child had visited family No. 6 on [this table.
11	“	Laborer,	15	“	3	“	“	7	“	“	No drainage facilities,	Damp,	3 “ “	
12	“	“	16	Female,	17	“	“	1	. . .	Low and damp,	“ “	No cellar,	6 feet from house; vault full,	Stagnant water under house.
			17	Male,	3½	“	“							
13	“	“	18	Female,	8	“	. . .	1	“	“ “	Drainage defective; waste pipe not trapped,	Basement room,	12 feet from house	
14	“	Carpenter,	19	“	22	“	. . .	5	Sand,	Good,	Soil pipe not ventilated,	Dry,	Water-closet in cellar,	Fatal case of diphtheria in brother's house in [Dec., 1881.
			20	Male,	35	“								
15	American,	Salesman,	21	Female,	48	“	. . .	2	Clayey Gravel,	“	Defect in drain pipe in cellar,	Damp,	Water-closets in bath room and cellar.	
16	Irish,	Painter,	22	Male,	1	“	Fatal,	6	Clay,	Fair,	No drainage facilities,	“	12 feet from house,	Received clothing from mother of family No. 6 [on this table.
17	“	Laborer,	23	Female,	13	“	. . .	1	Clayey Gravel,	“	Waste pipe not trapped,	“	14 “ “	
18	American,	Widow,	24	“	26	“	. . .	7	Clay,	Good,	Defect in drain pipe; waste pipe not trapped,	“	Water-closet in bath room.	
19	Irish,	Laborer,	25	Male,	7	February,	. . .	4	“	Low,	Waste pipe not trapped,	No cellar	15 feet from house,	Premises filthy.
			26	Female,	2	“								
			27	Male,	5	“								
20	“	Soap Maker,	28	Female,	6	“	Fatal,	1	Clayey Gravel,	“	No drainage facilities,	“ “	8 “ “	Stagnant water under house.
			29	“	7	“								
21	American,	Teamster,	30	Male,	4	“	“	4	Sand,	Fair,	Waste pipe not trapped,	Damp,	10 feet from house; vault full.	
22	Irish,	Laborer,	31	Female,	18	“	. . .	1	Clay,	Low,	“ “	“	12 “ “ “	Pool of stagnant water 18 feet from house.
23	American,	Painter,	32	“	30	“	. . .	2	Clayey Gravel,	Good,	Defect in drain pipe; waste pipe not trapped,	Dry,	Water-closet in bath room.	
			33	Male,	27	“								
24	“	Carpenter,	34	Female,	31	“	. . .	9	Sand,	“	Drainage into cesspool 8 ft. from house; w. p. not trapped,	“	8 feet from house; offensive.	
			35	Male,	3 mos.	“	Fatal,							
25	German,	Butcher,	36	“	3	“	. . .	10	Clayey Gravel,	Fair,	Drainage on surface,	“	3 feet from house: vault full,	Pool of stagnant water near house.
26	American,	Widow,	37	“	6	“	. . .	8	“ “	“	“ “	“	30 feet from house,	“ “ “ “
27	Irish,	Laborer,	38	Female,	3	“	. . .	6	“ “	Damp,	No drainage facilities,	No cellar,	12 feet from house: offensive.	
28	American,	Painter,	39	“	4½	March,	Fatal,	6	“ “	Fair,	. . .	Water in cellar,	Insufficient supply of water in water-closet,	Mother of family No. 6 boarded here, and had [given child's clothing to this family.
29	“	Bookkeeper,	40	Male,	7	“	. . .	5	“ “	Good,	Defect in drain pipe, and con. of w. p. and d. p. defective,	Dry,	Water-closet in bath room.	
			41	Female,	5	“								
			42	Male,	3	“								
30	“	“	43	“	40	“	. . .	2	“ “	“	Waste pipe not trapped; drain pipe defective,	“	Water-closet in cellar.	
31	“	Salesman,	44	Female,	7½	“	. . .	7	“ “	“	Drain pipe and soil pipe defective,	Damp.	Water-closet in cellar defective.	
			45	“	7½	“								
32	Irish,	Laborer,	46	Male,	6	“	. . .	6	“ “	Fair,	Waste pipe not trapped,	Dry,	25 feet from house.	
33	American,	Cabinet Maker,	47	Female,	2½	“	Fatal,	3	Sand,	“	Drain pipe defective,	Damp,	Water-closet in bath-room offensive.	
34	Irish,	Teamster,	48	“	22	“	. . .	6	Clayey Gravel,	“	Drainage into cesspool 25 ft. from house; w.p. not trapped,	“	Adjoining house; vault full,	Offensive odor from sink in kitchen.
35	American,	Dentist,	49	Male,	7	“	. . .	7	“ “	Good,	Drain pipe defective,	Dry,	Water-closet in cellar offensive,	Offensive odor caused by defective soil pipe.
36	Irish,	Laborer,	50	“	6	“	Fatal,	8	“ “	Fair,	No drainage facilities,	Damp,	10 feet from house; vault full.	
			51	“	8	“								
			52	Female,	5	“								
			53	“	3	“								
37	American,	Bookkeeper,	54	“	6	“	. . .	7	“ “	Good,	Defect in drain pipe,	“	Water-closet in b. r. not supplied with water,	Insufficient supply of water in water-closet in [cellar.
38	“	Merchant,	55	Male,	13	“	. . .	7	“ “	“	Satisfactory,	Dry,	Water-closet in bath room,	Soil pipe ventilated.
39	“	Stable Keeper,	56	Female,	7	“	. . .	7	“ “	“	Connection of waste pipe with drain pipe defective,	“	W. c. in b. r. insufficiently supplied with water,	
40	Irish,	Laborer,	57	“	3	“	. . .	4	Sand,	Low and damp,	Waste pipe not trapped,	Damp,	15 feet from house; vault full,	Stagnant water near house.
41	“	“	58	Male,	6	“	Fatal,	6	Clayey Gravel,	Fair,	“ “	Dry,	10 “ “ “	

vacated, forty-three of which were put in good sanitary condition. From its organization the board has caused to be made, by its inspector, a careful examination of every house in which cases of scarlet fever, typhoid fever and diphtheria occurred. Such part of the inspector's report as relates to diphtheria is published annually by the board. A portion of his report for 1882 is herewith submitted.

The board has paid particular attention to the prevention of contagious diseases, and, in addition to the publication and distribution of papers relative to scarlet fever, the board began in 1879 to fumigate every house in which there had been a case of that disease, whenever a request to that effect was made by the family. In 1880, when a fatal case of that disease, or diphtheria, occurred, the house was fumigated by an agent of the board. During the same year the board placed on houses in which there were cases of scarlet fever a yellow card, bearing in black letters the words, "Scarlet fever here." Much objection was at first made to this measure, but the practice was adhered to, and in 1882 the board placed cards with the words, "Diphtheria here," on houses in which there were cases of that disease. These cards are occasionally torn down, and in some cases decided objection is offered by the owners of the houses. Many of them feel that the value of their property will be lessened by the knowledge of the fact that there was a case of contagious disease in the house. In other instances objection is made by persons who do some business in the house, such as grocers, dressmakers and milkmen. They very naturally feel that their business will be temporarily injured by the knowledge of the presence of a contagious disease in the house.

In 1880 the board published a formula for a solution for disinfecting the fæces in typhoid fever cases, and offered to provide the material when asked to do so. In 1881 about one-half the cases were thus supplied. The value of the measure requiring physicians and householders to report cases of contagious diseases will be more fully realized when the small working capacity of the board is considered. The board consists of but three members. All the preliminary outside work is attended to by the sanitary inspector. If it were not for such provision the board could not obtain a knowledge of one-tenth of the cases occurring in the city. The city has an area of about 2,660 acres, and is poorly provided with horse-cars. Granting the importance of the restrictive measures adopted by the board, it will be seen that to derive any benefit from them it is necessary that the board should know of their presence as soon as possible. The law requires physicians and householders to report such cases at once; but the board, while distributing circulars calling attention to this law, takes but slight notice of a failure to report by the householder, for the particular reason that, in some instances, the diagnosis made by the physician did not accord with the facts. Consequently the householder's report would not be reliable. The physician could have no object in reporting to the board a case of simple continued fever as typhoid fever, although he might get credit from the family for having "broken up" a typhoid in a week or ten days. Neither would he report his cases of tonsillitis as diphtheria, although he may be gaining quite a local reputation by his remarkable success in the treatment of diphtheria. Whenever it was learned that a physician had been attending a case of contagious disease and failed to report it, he was at once notified by the board that a failure to comply with the law must not occur again. In accordance with the provisions of chapter 174 of the Acts of 1878, the board approved all death certificates, and while doing so, occasionally found a certificate of death from a contagious disease, no report of which had been made to the board. It was decided by the board to prosecute the next offender, and a physician residing in a neighboring city, having failed to report a case of diphtheria, was summoned to appear in court. All the facts in the case were proved, but for some reason the case was "placed on file." The moral effect of the trial was a good one, for since that time the board has had no cause to complain of physicians for non-compliance with their requests.

A certain individual was suspected of carrying on a lying-in hospital, but the board having no positive knowledge to that effect, could not make an examination of the premises. In the summer of 1881 it was found that a few deaths from cholera infantum were reported as occurring in the house, and the board, after visiting the premises, was satisfied that it was conducted as a lying-in institution. As the board had some doubt of its ability to prove a case in court it was decided not to prosecute. The party soon after moved from the city.

DISTRICTS.

The city was divided into sanitary districts, the principal points of interest in each being as follows:

District No. 1 has an area of about three hundred and thirty-seven acres. The soil is mainly clay. About half the district is thickly settled, principally by foreigners and their descendants, who live in small houses. Three-eighths of the district is vacant upland and one-eighth marsh. A large part of the settled portion of the district is low, being not more than thirteen feet above mean low water. All the pork-packing and rendering establishments in the city are in this district. It is well provided with sewers.

District No. 2, one of the earliest settled parts of the city, has an area of about one hundred and seven acres. The soil is clayey-gravel, with an elevation of about forty feet above mean low tide. It is populated almost entirely by native-born people, who live in good houses. Almost all parts of the district are provided with sewers.

District No. 3 has an area of about ninety-three acres. The soil is chiefly clay, and the general elevation of the district is but sixteen feet above mean low tide. About half the district is populated by native-born people, who live in good houses. There are sewers in almost all the streets. The other half of the district is vacant land.

District No. 4 has an area of about one hundred and seventy-one acres, with a sandy soil. The land is low, the average elevation above mean low tide being twenty feet. The foreign born slightly predominate in the district. The principal parts of the district are well provided with sewers.

District No. 5. This district has an elevation above mean low tide ranging from twenty to one hundred and forty feet. The soil is clayey-gravel. It has an area of about three hundred and sixty-one acres. The population is mainly native born. The greater part of the district is provided with sewers.

District No. 6. This district has an area of two hundred and eighty-five acres. The soil is clayey-gravel. The elevation of the district is from thirty-five to one hundred and fifteen feet above mean low tide. Only one-fourth of the district is populated, and mainly by foreigners and their descendants. There are very few sewers in the district.

District No. 7. The soil in this district is a clayey-gravel, with an elevation ranging from thirty-five to one hundred and forty feet above mean low tide. It has an area of one hundred and ninety-four acres. The inhabitants live in good houses, and are almost all native born. It is well provided with sewers.

District No. 8. This district has an area of four hundred and eighty-two acres. In the populated parts the soil is clayey-gravel, the elevation ranging from ten to one hundred and forty-five feet above mean low tide. About one-fourth of the district is populated, the remainder being divided between marsh and vacant upland. There are very few sewers in the district.

District No. 9. Not more than one-half of this district is settled. Population mainly native born. It has an area of about one hundred and seventy-four acres. About three-fourths of the inhabited portion is sand, the remainder being clay and clayey-gravel. It has an elevation of about forty feet above mean low tide. It is well provided with sewers.

District No. 10. This district has an area of four hundred and fifty-six acres, with a clayey-gravel soil, the elevation varying from ten to one hundred and twenty-two feet above mean low tide. It is populated mainly by native born. There are no sewers in the district.

The main points of interest in the several districts, into which the city has been divided, may be seen by reference to the following: —

DISTRICTS.	1	2	3	4	5	6	7	8	9	10
Soil,	Clay.	Clayey gravel.	Clay.	Sand.	Clayey gravel.	Clayey gravel.	Clayey gravel.	Clayey gravel.	Mainly sand.	Clayey gravel.
Elevation above mean low tide,	13 feet.	40 feet.	16 feet.	20 feet.	From 20 to 140 feet.	From 35 to 115 feet.	From 35 to 140 feet.	From 10 to 145 feet.	40 feet.	From 10 to 122 feet.
Area,	337 acres.	107 acres.	93 acres.	171 acres.	361 acres.	285 acres.	194 acres.	482 acres.	174 acres.	456 acres.
Dwellings,	761	708	298	521	850	265	465	167	285	142
Population,	5,021	4,900	1,899	3,369	5,268	1,164	2,878	857	1,531	674
Death rate per 1,000 in 1882,	24	12	22	17	14	27	15	13	11	19
Nativity of population,	Foreign.	Native.	Native.	Foreign ½. Native ½.	Native.	Foreign ⅔. Native ⅓.	Native.	Foreign ½. Native ½.	Native.	Native.
Scarlet fever cases reported in 1882,	5	0	7	6	10	2	4	0	0	5
Deaths from scarlet fever in 1882,	0	0	0	2	2	0	0	0	0	0
Diphtheria reported in 1882,	36	10	15	12	45	19	21	9	2	3
Deaths from in 1882,	14	1	6	2	12	9	6	1	1	0
Typhoid reported in 1882,	12	4	1	6	5	1	1	3	0	5
Deaths from in 1882,	0	2	1	1	1	0	0	1	0	2
Drainage,	Good.	Good.	Good.	Good.	Good.	Poor; very few sewers.	Good.	Poor; mainly into cesspools.	Good.	No sewers.
Most frequent causes of deaths in 5 years,	Phthisis.	Phthisis.	Phthisis.	Phthisis.	Phthisis.	Phthisis.	Phthisis.	Phthisis.	Phthisis.	Phthisis.

Cases of Scarlet Fever, Diphtheria and Typhoid Fever reported to the Board of Health in 1878, 1879, 1880, 1881 and 1882.

MONTHS.	SCARLET FEVER.					DIPHTHERIA.					TYPHOID FEVER.				
	1878.	1879.	1880.	1881.	1882.	1878.	1879.	1880.	1881.	1882.	1878.	1879.	1880.	1881.	1882.
January, ...	–	40	13	4	5	–	13	27	19	24	–	–	1	4	3
February, . . .	–	13	5	5	1	–	9	5	13	14	–	–	1	1	2
March, ...	9	21	4	2	–	11	6	9	14	32	–	–	–	3	3
April, ...	5	21	1	6	1	4	5	9	15	14	1	–	1	–	1
May, ...	2	18	4	2	1	4	3	1	15	15	–	1	2	3	–
June, ...	6	18	2	–	1	6	5	–	11	17	–	1	2	1	4
July, ...	1	6	–	–	1	3	2	6	9	14	1	1	1	–	–
August, ...	–	3	3	1	2	3	6	1	13	–	2	2	3	5	8
September, . . .	–	1	4	1	1	2	7	4	3	8	8	6	9	15	7
October, ...	20	4	5	1	8	11	20	9	21	6	3	1	9	16	5
November, . . .	41	10	1	2	7	12	22	12	8	9	3	2	6	17	2
December, . . .	24	16	1	1	11	14	15	25	14	19	–	1	4	6	3
Totals, ...	108	171	43	25	39	70	113	108	155	172	18	15	39	71	38

Reports of contagious diseases were not received before the month of March, 1878. Prior to that time the board had not requested physicians to report.

Deaths from Scarlet Fever, Diphtheria and Typhoid Fever in 1878, 1879, 1880, 1881 and 1882.

MONTHS.	SCARLET FEVER.					DIPHTHERIA.					TYPHOID FEVER.				
	1878.	1879.	1880.	1881.	1882.	1878.	1879.	1880.	1881.	1882.	1878.	1879.	1880.	1881.	1282.
January, ...	–	4	2	–	–	4	6	7	7	11		–	–	–	1
February, . . .	–	1	1	–	1	4	4	–	4	5	–	–	–	1	–
March, ...	–	1	1	–	–	5	–	–	7	7	–	–	–	2	1
April, ...	1	2	–	–	–	1	1	1	2	8	–	–	–	–	1
May, ...	–	–	–	1	–	–	–	–	3	5	–	1	–	–	–
June, ...	–	1	–	–	–	1	1	–	3	2	–	–	1	–	1
July, ...	–	2	–	–	–	2	–	–	2	1	–	–	1	–	–
August, ...	–	–	–	–	1	1	4	–	3	–	2	–	1	–	–
September, . . .	–	–	2	–	–	1	2	–	2	1	1	1	–	1	3
October, ...	3	–	–	–	–	2	5	2	6	1	1	–	2	2	1
November, . . .	4	3	–	–	–	1	2	1	2	7	–	1	1	1	–
December, . . .	7	2	–	–	2	5	4	8	3	4	1	–	1	1	–
Totals, ...	15	16	6	1	4	27	29	19	44	52	5	3	7	8	8

A map like that accompanying this paper, in which the boundaries of the sanitary districts are shown, and also the location of contagious diseases, was published annually by the board until 1882, when, objection being made by a number of property owners, to the effect that its appearance in the annual report was having an injurious effect on the value of their property, the city council refused to appropriate sufficient money to defray the expense of its publication. The following figures may prove interesting. In studying these and other figures presented in this paper it should be remembered that the population of the city has icrneased at the rate of one thousand annually: —

Death Rate per Thousand for a period of Eleven Years.

YEAR.	Deaths.	Rate per Thousand.
1872,	400	24.30
1873,	425	21.70
1874,	490	22.96
1875,	501	22.86
1876,	444	20.18
1877,	441	19.15
1878,	385	16.21
1879,	398	16.9
1880,	428	17.1
1881,	459	17.4
1882,	472	17.1

THE

WEEKLY MORTALITY REPORTS

OF

MASSACHUSETTS CITIES AND TOWNS.

THE

WEEKLY MORTALITY REPORTS OF MASSACHUSETTS CITIES AND TOWNS.

By way of introduction to the statistical details presented in the following pages, it should be stated that the results herewith given are necessarily incomplete, in consequence of the incompleteness of the returns from which they are compiled. They should not be confounded with the Registration Reports annually made up and published under the direction of the Secretary of the Commonwealth. The latter are the result of statutory requirements carefully carried out through a long series of years, their value having been increased from time to time by the introduction of various important data.

In either case the individual facts from which mortality reports are compiled must be identical, both depending upon certificates of the cause of death.

The registration reports on the one hand are presumably full and complete and represent the entire state, while the reports forwarded to the Health Department weekly by the same local officers (town clerks and city registrars), are entirely voluntary, and represent a portion only of the population, chiefly the cities and large towns, and those other towns whose clerks have complied with the request for weekly returns of mortality.

A variety of causes affects the mortality of a given population, such as climate, occupation, intemperance, neglect of sanitation, social status, movements of population, epidemics of infectious diseases, and overcrowding in towns and public institutions. In addition to these, certain special circumstances influence the results obtained in the weekly reports of the Health Department.

1. The preponderance of cities and large towns contributing returns produces an increased death-rate.

2. In consequence of occasional failure to report on the part of a city or town, there is a slight weekly variation in the reporting population.

3. The weekly returns being made up on Saturday of each week, the sum of the returns does not correspond exactly to those of a calendar year. With these sources of slight inaccuracy or error, there is a marked correspondence with the results obtained in the registration reports of previous years, with the added value of a consideration of the effect of seasons and of meteorological conditions.

Death-rates may be taken as a fair index of the sanitary condition of a given population, although liable, as already stated, to many sources of error, the probability of error diminishing in proportion to the number of the population under consideration, the length of time during which observations are made, and the accuracy of individual data.

Registration of *Disease* would add much value to the results already obtained by the registration of *Mortality*. The advantage of such a plan was clearly pointed out in the Seventh Annual Report of the State Board of Health* (1876), and valuable observations were made in Massachusetts at that time, and also at other periods, before and after that date.† But the plan was not continued for a longer period than one or two years in either instance, in consequence of the limited number of observers who contributed returns.

The State Board of Health of Michigan has pursued a similar plan for several years, and annually publishes the results of the same. The province of Ontario also publishes a weekly report, and a chart showing the distribution and prevalence of prevailing diseases.

The weekly reports which form the basis of the following tables have been compiled each week for the past ten years and published for the benefit of the public by the Health Department.

An attempt has recently been made, with some measure of success, to obtain a more complete report from all cities and towns, by a direct invitation addressed to all town-clerks throughout the State. In reply to this request about one hundred cities and towns are now reporting weekly in place of about thirty-five who had previously reported — the increase being chiefly in the small towns. Since this result was not obtained until near the close of 1883 the figures for that year are affected but little by the increase in reports. The average population of reporting towns and cities for 1883 was 1,111,500. (The population at present reporting is about 1,400,000 or nearly three-fourths of an estimated population of 1,900,000.)

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* Seventh Annual Report of State Board of Health of Massachusetts, pp. 477-492.

† Communications of Massachusetts Medical Society. 1857, 1858.

Through the kindness of the U. S. signal officer at Boston weekly meteorological reports have been sent to the office of the Health Department, showing the various conditions of weather prevailing at Boston, and in view of the fact that this report is made up chiefly from data observed in the cities and towns of Eastern Massachusetts, the conditions therein expressed may be taken as a fair representation of the meteorological conditions affecting the reporting population.

In the column of figures marked Barometer, the figures indicate the weekly means of observations. For a clearer and more definite view, by which the entire annual range of air-pressure may be shown, the chart may be consulted. The figures at the left of the chart represent the air-pressure in inches upon the mercurial barometer.

The figures in the first column marked Thermometer indicate the means of maximum temperature for each week (three daily observations at 7 A.M. 3 P.M. and 11 P.M.), those in the second column indicate the means of minimum temperatures, the difference being the mean range of temperature for the week. These variations are more clearly shown upon the chart, the figures at the left indicating the Fahrenheit scale, and those at the right, the Centigrade.

The figures in the next column indicate the weekly precipitation of rain in inches, the same being also shown upon the chart at the top.

In the next column the degree of humidity is indicated, the maximum of 100 representing complete saturation.

The remaining columns contain the data obtained from the weekly reports of mortality of cities and towns, each number

General Summary.

DATE.	Barometer.	Maximum Thermometer.	Minimum Thermometer.	Rain. — Inches.	Humidity.	Total Deaths.	Deaths under 5.	Consumption.	Acute Lung Diseases.	Typhoid Fever.	Diarrhœal Diseases.	Scarlet Fever.	Measles.	Diphtheria and Croup.	Puerperal Fever.	Cerebro - Spinal Meningitis.	Whooping-Cough.	Malarial Fever.	Small-pox.	Erysipelas.	Death-rate.
1883.																					
January 6, . .	30.268	34	16	.57	72	387	123	76	66	7	2	4	3	34	1	2	1	–	–	–	19.84
" 13, . .	29.996	28	9	.49	75	375	116	51	44	7	3	4	5	29	2	2	–	–	–	3	21.58
" 20, . .	30.268	35	19	1.18	77	368	115	70	43	10	7	7	3	20	2	5	6	–	–	7	19.79
" 27, . .	30.232	31	11	.57	65	379	94	63	52	3	5	5	3	28	4	3	1	–	–	3	20.32
February 3, . .	30.209	39	24	1 35	83	407	132	71	52	4	6	6	5	16	3	8	5	–	–	–	20.78
" 10, . .	30.051	38	20	.63	65	430	161	77	60	4	7	10	1	34	5	5	2	–	–	3	21 25
" 17, . .	30 189	41	22	.91	74	405	110	75	71	5	4	11	–	24	5	4	2	1	–	2	19.41
" 24, . .	30 250	39	18	.20	60	455	131	93	67	4	2	3	3	25	4	8	–	1	–	3	19.94
March 3, . .	30.129	39	20	.53	65	422	132	75	57	4	11	5	3	26	2	6	3	–	–	3	19.31
" 10, . .	30.016	31	13	1.51	66	450	138	67	65	4	7	6	2	17	3	8	2	–	–	3	19.00
" 17, . .	29.765	40	22	–	61	488	135	76	91	8	6	8	2	17	1	12	4	–	–	4	20.78
" 24, . .	29.844	39	23	–	65	474	150	93	93	5	4	6	8	27	3	8	2	1	–	3	20.44
" 31, . .	29 903	43	29	.20	67	521	155	96	108	12	4	7	4	23	2	5	1	–	1	5	22 21
April 7, . .	30.015	50	32	.44	69	474	148	84	82	5	13	10	6	19	3	6	2	1	–	3	21.74
" 14, . .	30.125	57	37	1.65	80	453	130	67	75	9	7	10	12	13	4	7	1	–	–	3	19.83
" 21, . .	29 966	60	39	.37	67	506	141	65	95	7	7	15	10	20	3	6	2	1	–	–	22.78
" 28, . .	29.874	57	36	.37	71	441	127	82	75	5	10	11	7	17	3	5	1	1	–	5	19.57
May 5, . .	30 189	56	39	.16	76	391	105	60	59	2	8	4	8	16	1	5	1	–	1	1	20.11
" 12, . .	30 013	64	46	.18	68	475	138	71	73	8	11	7	13	22	5	9	–	1	–	2	22.46
" 19, . .	30.058	63	44	.85	67	424	130	53	79	5	7	6	16	27	5	7	2	2	–	2	20.44
" 26, . .	29.764	69	51	3.41	81	436	166	62	51	7	7	11	15	26	1	9	3	–	–	1	20.40
June 2, . .	29.957	75	55	.51	68	418	132	66	49	4	7	12	20	16	2	8	4	1	–	1	19.66
" 9, . .	30 006	85	67	.47	73	424	149	61	41	2	9	8	24	15	3	9	4	–	–	5	19.48
" 16, . .	29.898	81	60	.25	65	450	148	70	45	6	14	15	23	20	3	4	1	2	–	3	21.06
" 23, . .	29.922	77	60	.06	77	380	135	60	22	1	22	4	12	17	3	7	1	–	–	1	16.97
" 30, . .	29 965	80	60	1.29	78	293	107	57	18	7	22	8	6	17	2	3	1	1	–	–	16.49
July 7, . .	29 950	89	64	.40	67	503	230	60	23	3	94	4	7	22	5	5	2	2	1	3	22 04
" 14, . .	29.982	80	59	.94	80	607	328	68	19	7	138	2	4	12	3	3	1	–	–	2	27 01
" 21, . .	30 052	80	60	.15	73	504	272	51	12	3	164	3	3	13	1	3	–	–	–	2	22.22
" 28, . .	29.945	80	62	1.07	72	626	339	73	26	9	246	4	2	13	4	4	1	1	–	–	28.43

August 4, . .	29.874	82	60	.17	66	588	286	83	19	6	186	2	2	13	2	5	1	2	–	1	26 53
" 11, . .	30.079	77	58	–	64	525	266	70	1	7	162	9	1	9	–	9	2	1	–	–	25.72
" 18, . .	30.046	75	57	.32	78	526	245	83	13	13	122	7	4	16	5	5	1	–	–	–	22.86
" 25, . .	29.924	86	63	.07	62	545	235	96	19	20	133	6	1	13	4	–	1	1	–	–	25.57
September 1, . .	30.111	70	52	–	64	498	225	55	15	15	130	3	–	12	1	7	–	–	–	–	22.96
" 8, . .	29.856	77	50	.03	67	463	183	81	15	18	88	7	–	12	1	5	3	–	–	1	21.21
" 15, . .	30.210	65	51	.10	79	468	200	58	19	14	83	5	1	15	3	5	1	–	–	1	22.45
" 22, . .	30.133	68	55	.04	75	389	165	66	53	27	73	6	–	10	–	4	–	–	–	–	17.62
" 29, . .	29.944	68	47	.84	69	450	172	75	18	22	59	1	–	18	–	4	–	3	–	3	20.08
October 6, . .	30.056	56	38	1.99	70	402	159	61	20	26	43	7	–	23	1	3	1	–	–	–	19.61
" 13, . .	30.232	64	43	.17	91	403	140	63	32	13	40	10	–	23	3	3	1	–	–	–	18.53
" 20, . .	30.361	57	39	1.08	72	397	130	64	35	13	21	9	–	24	1	2	1	–	–	–	19.34
" 27, . .	30.206	47	35	2.47	86	367	121	52	26	12	27	6	1	27	–	2	2	–	–	–	18.69
November 3, . .	29.871	55	40	1.13	73	380	115	60	31	12	13	7	–	31	2	1	3	–	–	3	19.08
" 10, . .	29.999	60	40	.48	71	345	99	62	30	12	9	11	1	21	3	3	–	–	–	1	17.52
" 17, . .	29.968	43	24	.11	65	352	108	62	36	14	19	9	–	28	1	1	2	–	–	–	17.23
" 24, . .	30.219	59	43	.17	80	432	111	61	51	9	6	11	–	28	1	2	2	–	–	2	18.59
December 1, . .	30 256	44	28	1.32	64	370	89	63	34	14	5	6	–	21	2	2	1	1	1	–	16 56
" 8, . .	30.195	44	28	.15	75	425	119	72	44	8	11	5	3	35	1	4	4	1	–	2	19.52
" 15, . .	29.923	46	27	.05	73	502	130	83	56	14	14	15	1	53	6	3	–	–	–	2	21.60
" 22, . .	30.101	27	12	2.40	82	391	105	65	50	11	6	8	–	31	–	–	2	–	–	2	18 60
" 29, . .	29.995	34	16	1.06	79	474	136	64	64	16	12	5	1	35	2	9	3	–	–	3	21.05
	–	–	–	34.86	–	23,056	8,156	3,594	2,384	483	2,116	371	246	1,123	127	255	87	25	4	94	–

expressing the sum of reported deaths from the disease or diseases named at the head of the column for the week ending on the day indicated at the left of the number. The same data are indicated also upon the charts in such a manner as to show more clearly the prevalence of each disease at different seasons of the year.

The months are also indicated at the bottom of the charts, but it is evident that any data expressed in periods of months, cannot necessarily be as accurate as when expressed by weekly periods, in consequence of the mode in which the returns are received and recorded, the initial weeks in some months reporting deaths which occurred during the latter part of the previous months. E. g.: The week ending March 3 includes four days of the previous February, &c.

The diseases reported in the tabular statement are those having a special sanitary significance, and are as follows:—

Total reported deaths.
Deaths of children under 5 years of age.
Consumption.
Acute Lung Diseases.
Typhoid Fever.
Scarlet Fever.
Puerperal Fever.
Diarrhœal Diseases.
Measles.
Diphtheria, and Croup.
Whooping-cough.
Cerebro Spinal Meningitis.
Malarial Fever.
Erysipelas.
Small-pox.
  Mortality-rates.

The twelve months included in this report have not presented an unusual mortality and so far as is shown by the returns no one of the diseases specified has prevailed in the State during the year 1883 to a degree which should entitle it to be classed as epidemic.

Total Deaths.

The whole number of deaths reported for the year from cities and towns included in the report was 23,056, the aver-

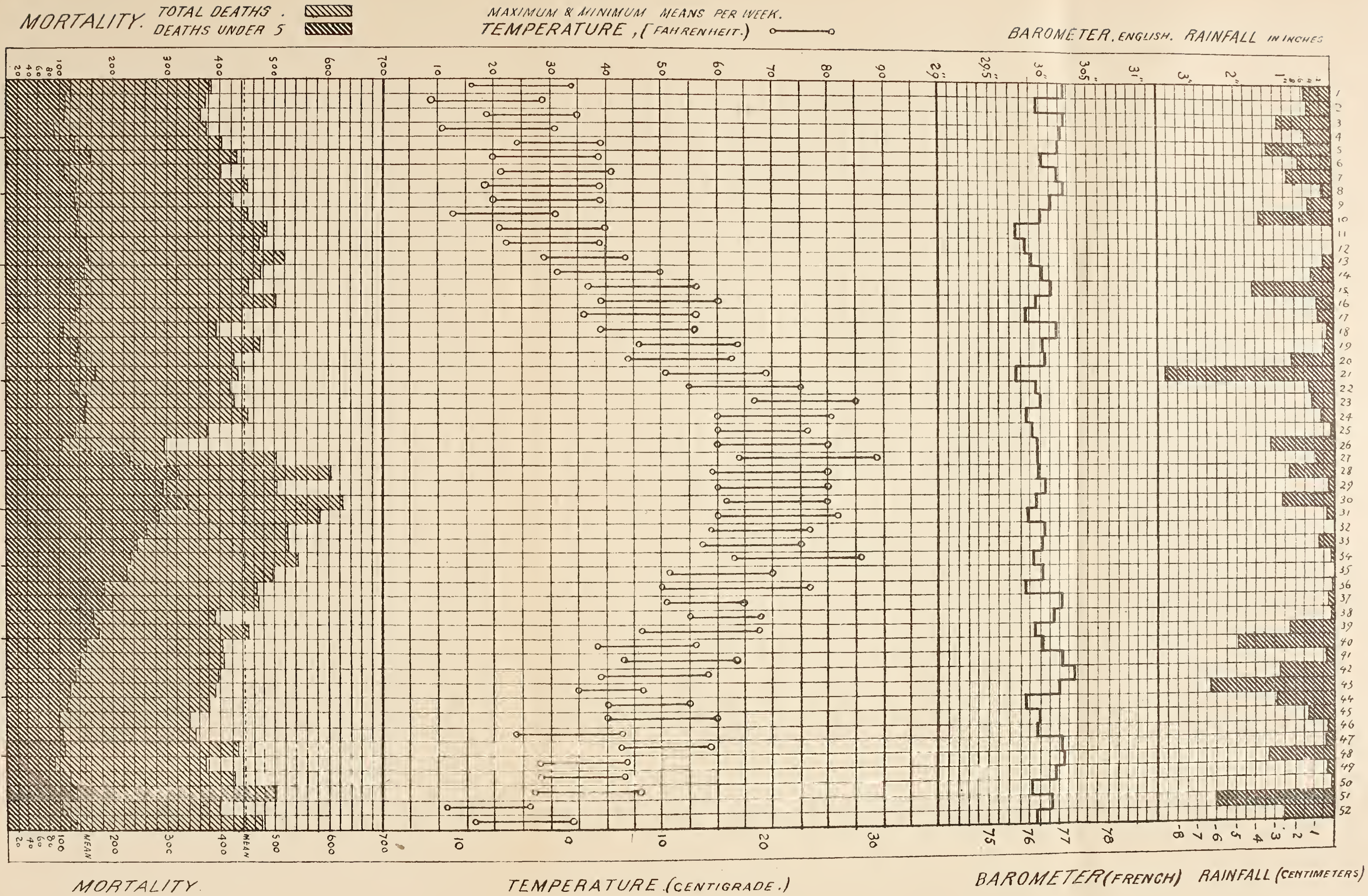


Chart showing the total weekly mortality from population as reported; also the mortality of children under 5 years of age, the mean range of temperature for each week, the mean height of barometer and the total weekly rainfall at Boston.

age number per week 443. Greatest number 626, in the week ending July 28. Least number 293, in the week ending June 30.

The weekly average number of deaths reported for each month was as follows : —

January,	377	July,	560
February,	424	August,	546
March,	471	September,	453
April,	468	October,	392
May,	431	November,	377
June,	393	December,	432

The months in which the least number of deaths per week was reported were January and November and those in which the greatest number was reported were July and August.

The sharpest fluctuations of this table are (as usual in the crowded cities and large towns of the United States) caused by the mortality of young children, the class upon whom a high rate of mortality usually expends itself.

No estimate of the mortality of a population can be correct which does not take into account the movements of the population. The expense of obtaining an accurate census has limited the work to decennial periods, supplemented in Massachusetts by a similar work performed by the State, thus giving an actual enumeration every five years.

To provide for the intervening years we have adopted a calculation, based upon the annual increase or decrease of population for the decennial period, as compared with the annual increase or decrease of polls for the same period, and also for each year since the last census year, the polls being enumerated annually.

Although no calculation can give strictly accurate results, this mode has been found to be quite satisfactory when compared with the few instances in which actual enumerations have been made.

One cause of an increased death-rate in large cities is the existence in them of public institutions in which are collected the sick, aged, infirm, poor and ill-conditioned, many of whom have come hither from other places.

An exaggerated instance may be named as an illustration. The town of Tewksbury, including its almshouse population, has an annual death-rate of nearly 100 per 1,000; while that of its population outside the almshouse is rarely more than 15 per 1,000.

Of the 23,056 recorded deaths, the percentage of mortality in the different quarters of the year were as follows: —

	First Quarter. Per Cent.	Second Quarter. Per Cent.	Third Quarter. Per Cent.	Fourth Quarter. Per Cent.
Total deaths, . . .	24.11	24.13	29.06	22.7
Deaths under 5, . .	20.75	21.53	38.57	19.15

Deaths under Five Years.

The whole number reported was 8,156, the weekly average for the year being 158. The least number reported was during the week ending January 27, — 94 deaths; the greatest number in the week ending July 28, — 339 deaths. The excessive increase is due to the predominance of diarrhœal diseases during the hot months of summer, as will be seen by reference to the column of diarrhœal diseases.

The ratio of deaths under 5 to total deaths was one in 2.8, or 35.37 per cent. The average for the previous ten years, 1871 to 1880, for the whole State was 35.54.

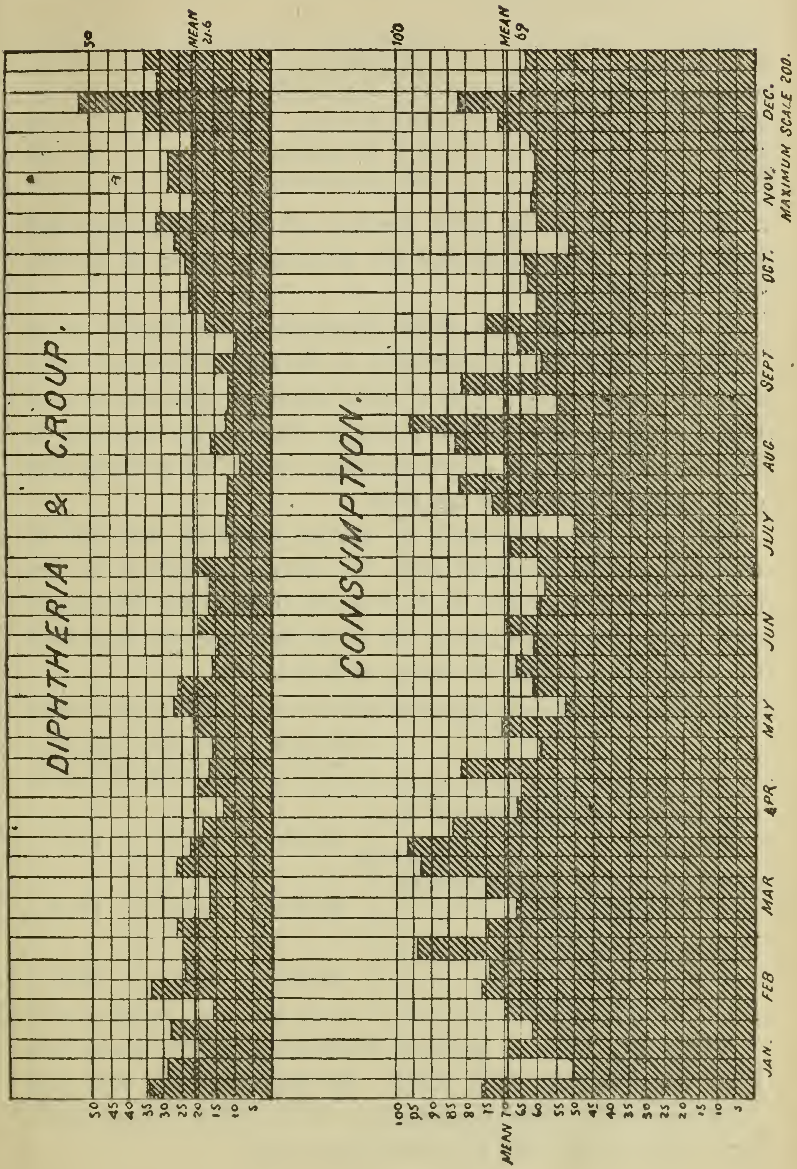
The average weekly number of deaths for each month, of children under 5, was as follows: —

January, ...	112	July, ...	292
February, ...	138	August, ...	258
March, ...	142	September, ...	189
April, ...	136	October, ...	137
May, ...	135	November, ...	108
June, ...	134	December, ...	116

Months having least number of deaths, November and January. Months having greatest number of deaths, July and August.

Consumption.

The reported number of deaths from consumption was 3,594. The reported weekly average for the year was 69.


DIPHTHERIA & CROUP.
CONSUMPTION.
50
MEAN 21.6
100
MEAN 69
50 45 40 35 30 25 20 15 10 5
100 95 90 85 80 75 MEAN 70 65 60 55 50 45 40 35 30 25 20 15 10 5
JAN. FEB MAR APR. MAY JUN JULY AUG. SEPT OCT. NOV. DEC.
MAXIMUM SCALE 200.

The average weekly number of deaths reported for each month was as follows : —

January,	65	July,	63
February,	79	August,	83
March,	81	September,	67
April,	74	October,	60
May,	61	November,	61
June,	63	December,	69

Months having the least number of deaths, October and November. Months having the greatest number of deaths, March and August.

By reference to the chart illustrating the fatality from Phthisis, a high rate of mortality in the late winter and early spring is noticeable. This is not a constant characteristic of the disease in the North Atlantic States, the records in Massachusetts for ten years showing a tolerably uniform rate of mortality throughout the year.

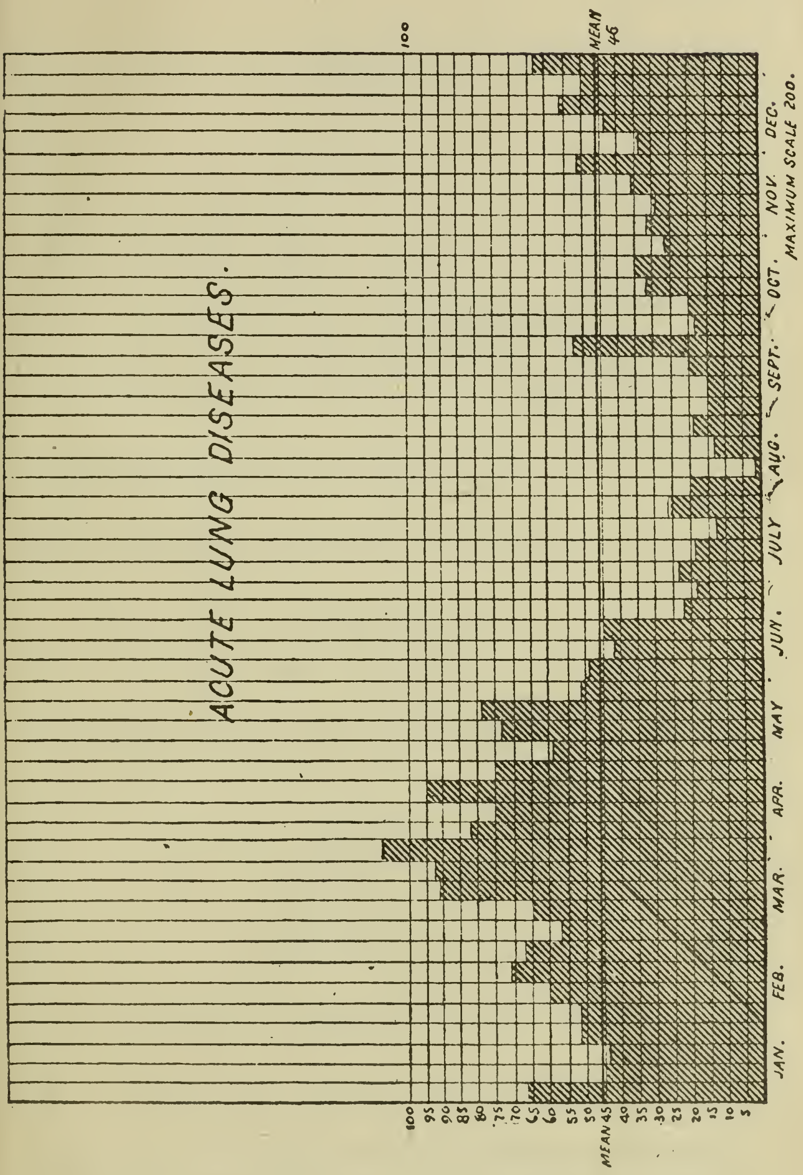
The ratio per thousand of deaths reported was 157.2, which is nearly identical with the results obtained by the mortality reports of the U. S. Census of 1880 for Massachusetts, and also with those of the State Registration Report of the same year, the result being as follows : —

	Total Deaths reported.	Deaths from Consumption.	Ratio per 1,000 Deaths.
U. S. Census. Mortality Reports for Mass., 1880,	33,150	5,207	157.
Thirty-ninth State Registration Report for Mass , 1880,	35,292	5,494	155.6
Weekly Mortality Reports for Mass., 1883,	23,056	3,594	155.9

There has been a gradual diminution in the death-rate from consumption since 1857. In that year the rate was 3.95 per 1,000 of the population ; and in 1879, 3.04 ; 1883, 3.08 ; the average for 24 years being 3.48.

Acute Lung Diseases : Pneumonia, Bronchitis, Asthma, Pleurisy.

The number of deaths reported from acute lung diseases was 2,384. The weekly average, 46.


ACUTE LUNG DISEASES.
100
MEAN 46
100
95
90
85
80
75
70
65
60
55
50
MEAN 45
40
35
30
25
20
15
10
5
JAN.
FEB.
MAR.
APR.
MAY
JUN.
JULY
AUG.
SEPT.
OCT.
NOV.
DEC.
MAXIMUM SCALE 200.

The average weekly number reported in each month was as follows :—

January,	51	July,	20
February,	62	August,	13
March,	81	September,	24
April,	82	October,	28
May,	65	November,	37
June,	35	December,	49

Months having least number of deaths, July and August. Months having greatest number of deaths, March and April.

The chart illustrative of acute lung diseases presents a double curve increasing with tolerable regularity to a maximum in March, and thence descending to a minimum in August, after which there is a uniform increase to the close of the year.

The ratio per 1,000 deaths from acute lung diseases was 103.4.

The ratio of deaths per 1,000 of the population living was 2.15.

Typhoid Fever.

The number of reported deaths from typhoid fever was 483, and the weekly average, 9.

The average weekly number in each month was distributed as follows : —

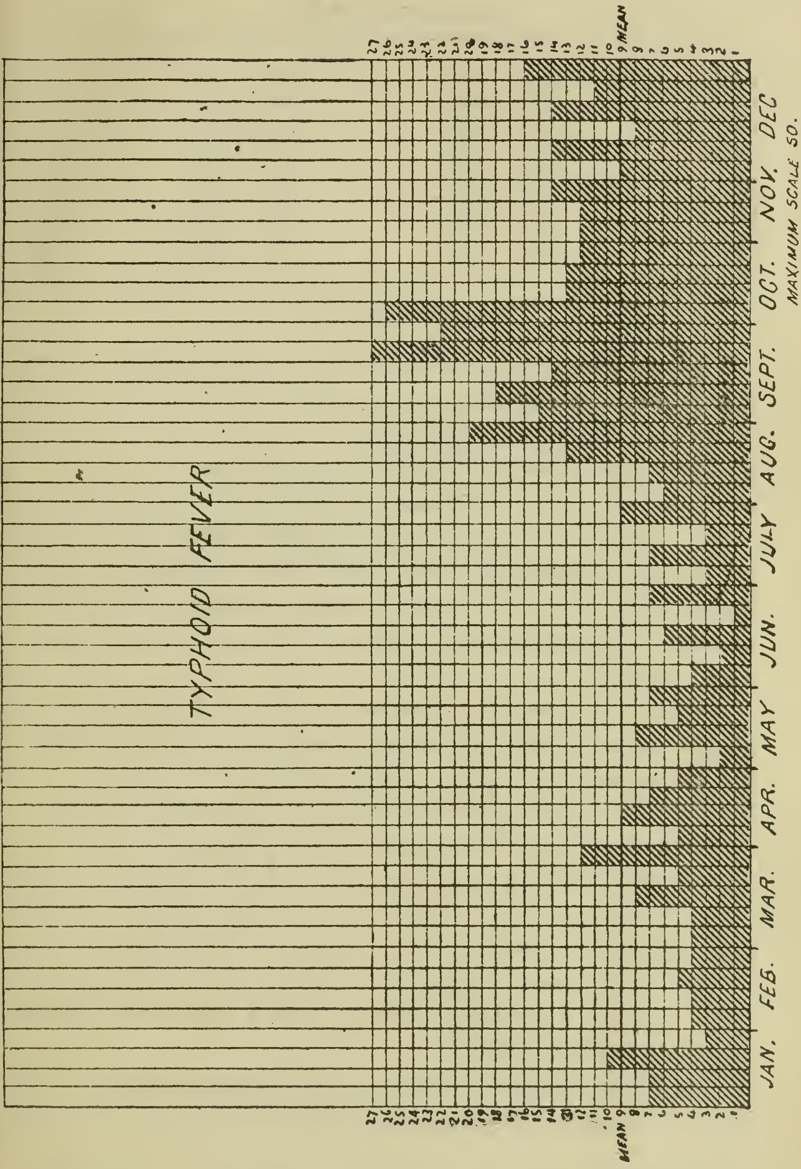
January,	7	July,	5
February,	4	August,	11
March,	7	September,	19
April,	6	October,	16
May,	6	November,	12
June,	4	December,	13

The months having the least number of deaths were February and June.

Those having the greatest number were September and October.

More than two-thirds of all the deaths from typhoid fever occurred in the last half of the year, the disease maintaining its common characteristic as a disease of the autumn months.

The ratio per 1,000 deaths from all causes was 20.9, which was less than that for any year for twenty-seven years, except 1879. The records for other years were as follows : —


TYPHOID FEVER
JAN.
FEB.
MAR.
APR.
MAY
JUN.
JULY
AUG.
SEPT.
OCT.
NOV.
DEC
MAXIMUM SCALE 50.
MEAN
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27

Ratio of Deaths from Typhoid Fever to Deaths from all Causes (per 1,000 Deaths).

1857,	46.9	1866,	45.3	1875,	30.6
1858,	42.7	1867,	42.4	1876,	27.4
1859,	43.8	1868,	34.9	1877,	26.7
1860,	39.7	1869,	46.2	1878,	22.3
1861,	40.6	1870,	48.8	1879,	19.4
1862,	48.8	1871,	39.9	1880,	24.9
1863,	51.6	1872,	48.6	1881,	29.4
1864,	46.6	1873,	41.5	1882,	29.4
1865,	64.3	1874,	35.6	1883,*	20.9

* Ratio of reporting towns.

Typhoid fever has been shown to be, more than any other, a filth disease, abounding in localities where cesspools, ill-constructed sink-drains and vaults are in common use in the proximity of household supplies of drinking-water, either in wells or in cisterns.

In consequence of this fact, a general report embracing every town and city in the State would probably show a somewhat greater ratio than that above stated, since the ratio of small towns (in which polluted wells are more commonly used) would be much greater.

May not the gradual decrease in the mortality from this disease be reasonably attributed to sanitary measures, notably the introduction of pure water-supplies into many of our smaller cities and large towns during the past fifteen years?

The average annual mortality from typhoid fever for the decade 1861–1870, was 46.9 per 1,000 deaths from all causes.

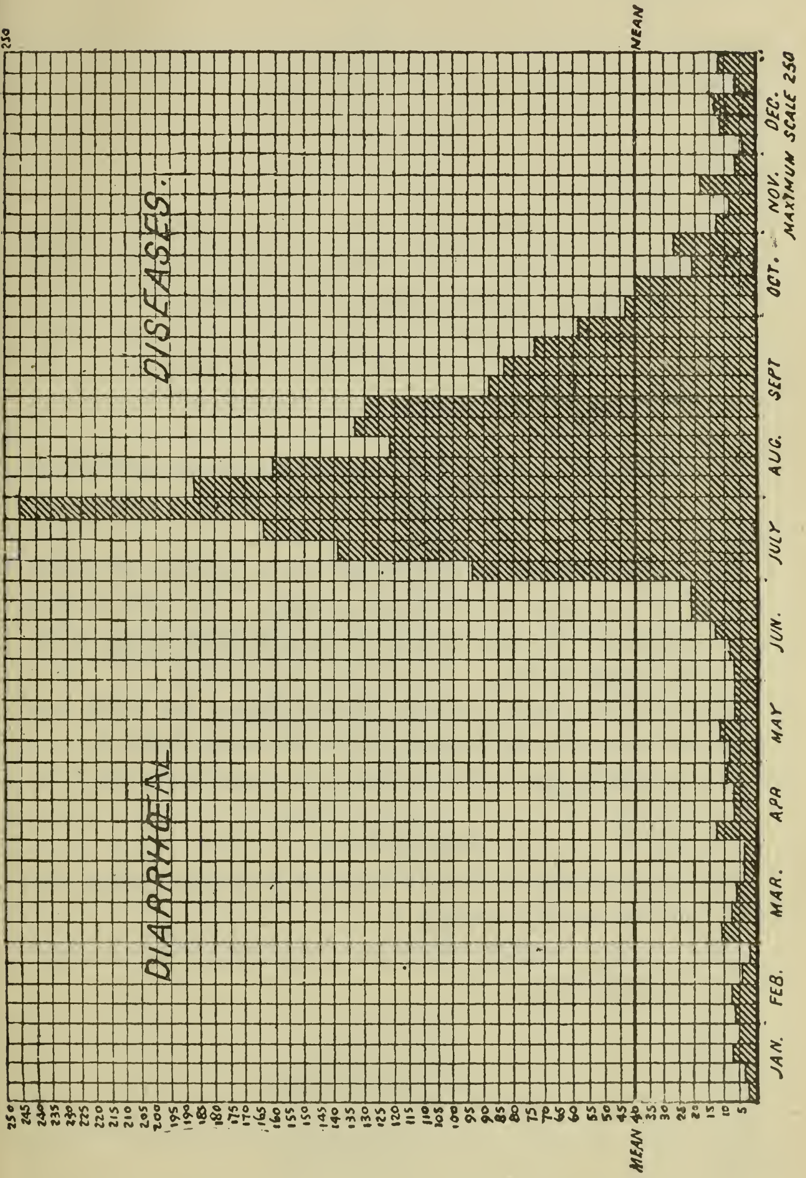
For the decade 1871–1880, the average annual mortality per 1,000 deaths was 31.7, a decrease of 32 per cent.

The U. S. Census Reports of Mortality for 1880 report a ratio of 31.2 from typhoid fever per 1,000 of all deaths from the entire country.

The mortality per 1,000 of the living population from typhoid fever in Massachusetts in 1883, was .4.

Diarrhœal Diseases, including Diarrhœa, Dysentery, Cholera Infantum, Cholera and Enteritis.

The number of reported deaths from diarrhœal diseases was 2,116, and the weekly average 41.


DIARRHOEAL
DISEASES.
MEAN
MEAN
JAN.
FEB.
MAR.
APR
MAY
JUN.
JULY
AUG.
SEPT
OCT.
NOV.
DEC.
MAXIMUM SCALE 250
250
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
105
110
115
120
125
130
135
140
145
150
155
160
165
170
175
180
185
190
195
200
205
210
215
220
225
230
235
240
245
250

The average weekly number in each month was distributed as follows: —

January,	4	July,	160
February,	5	August,	150
March,	6	September,	87
April,	9	October,	33
May,	8	November,	12
June,	15	December,	10

The two months having the least number of deaths from this group of diseases were January and February. The months having the greatest number were July and August.

The mortality during the last half of the year from these diseases was 89.9 per cent. of the whole number for the year, and for the three months, July, August and September, it was 79.3 per cent.

The powerful agency of heat in its effect on the prevalence of this class of diseases is shown in like manner with previous years.

The ratio of deaths to that of the whole number of deaths was 9.18 per cent. = (91.8 per 1,000). In 1879 it was 8.05 per cent. In 1880 it was 10.20. In 1881 it was 8.78. In 1882 it was 10.08.

The reported ratio for the United States for 1880 was 8.66 per cent. (U. S. Census, 1880, Mortality Table.)

The mortality per 1,000 of the living population was 1.9.

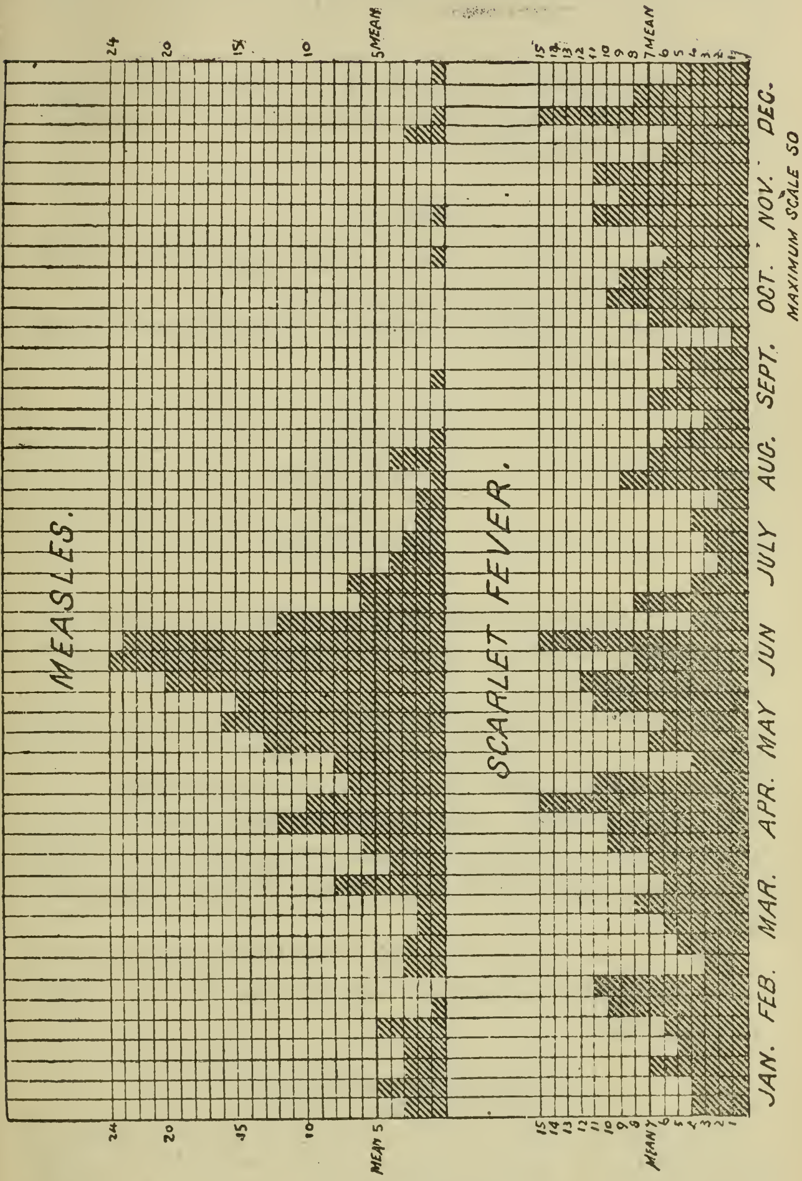
Scarlet Fever.

The total number of deaths reported from this disease was 371, and the weekly average 7.

The average weekly mortality of reported cases in each month was as follows: —

January,	5	July,	3
February,	7	August,	6
March,	6	September,	4
April,	11	October,	8
May,	7	November,	9
June,	9	December,	8

The two months having the least number of deaths from scarlet fever were July and September. Those having the greatest number were April and November.


MEASLES.
24
20
15
10
MEAN 5
SCARLET FEVER.
15
14
13
12
11
10
9
8
MEAN 7
6
5
4
3
2
1
JAN.
FEB.
MAR.
APR.
MAY
JUN
JULY
AUG.
SEPT.
OCT.
NOV.
DEC.
MAXIMUM SCALE 50

The ratio of deaths from scarlet fever to deaths from all causes was 16.2 per 1,000, being much less than the average for the twenty years 1861–1880, inclusive, — the average being 36.6.

The ratio of deaths per 1,000 of the living population was .34, which was also less than the average for the specified twenty years 1861–1880.

*Measles.**

The whole number of reported deaths from measles for the year was 246, the weekly average being 5.

The average weekly mortality of reported cases in each month was as follows : —

January,	3	July,	4
February,	2	August,	2
March,	4	September,	–
April,	9	October,	–
May,	13	November,	1
June,	17	December,	1

The two months having the least number of deaths were September and October. Those having the greatest number were May and June.

The unusual fatality from measles in May and June was of a local character, and was chiefly confined to the city of Boston and the immediate suburban cities and towns.

The ratio of deaths from measles to deaths from all causes was 10.7 per 1,000, being considerably greater than for the twenty years 1861–1880, the average for those years being 7.38.

The ratio of deaths per 1,000 of the living population was .221, being also greater than the average for the twenty years specified.

Diphtheria and Croup.†

Previous to 1858 the term diphtheria did not appear in the Registration Reports of the State, but both before and after that date croup appears to have prevailed at a tolerably uniform rate.

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* See chart, page 79.

† See chart, page 71.

A growing belief in the identity, or at least a close pathological relation of these diseases renders it necessary to combine them in a report of this nature.

The careful summary of these diseases for a period of ten years, as shown by Dr. Folsom in the Thirty-ninth Registration Report (1880), gives a total of 18,714 cases, an average of 1,871 per year, being 11.33 per 1,000 for the ten years by the Census of 1875, or an annual death-rate per 1,000 of 1.13.

The total number reported for the year 1883 was 1,123; the weekly average, 21.6.

The death-rate per 1,000 of living population was 1.01, being less than for the ten years embraced in the summary mentioned above, 1871–1880.

The mortality per 1,000 deaths was 49.1, also somewhat less than for the ten specified years (57.8). It was also slightly in excess of the average for twenty-three years, — 1858–1880 (47.8).

The average weekly mortality of reported cases was as follows: —

January,	28	July,	15
February,	25	August,	13
March,	22	September,	13
April,	17	October,	24
May,	23	November,	27
June,	17	December,	35

The three months having the least number of deaths were July, August and September; and those having the most were November, December and January. Its prevalence by seasons followed the results of the ten specified years.

Puerperal Fever.

The total number of deaths reported from puerperal fever was 127, an average weekly mortality of 2.4.

The weekly average per month was distributed as follows: —

January,	2	July,	3+
February,	4+	August,	3
March,	2	September,	1
April,	3+	October,	1+
May,	3	November,	2
June,	3	December,	2

The months having the least mortality per week were September and October. Those having the greatest were February, April and July.

This disease does not appear to be materially affected by meteorological conditions, but bears a tolerably uniform ratio to the number of births from month to month.

The ratio per 1,000 deaths from all causes was 5.6, which was greater than that of previous years.

The mortality per 1,000 of the living population was .114, which was also considerably greater than that of previous years.

Cerebro-Spinal Meningitis.

The total number of deaths reported from cerebro-spinal meningitis was 255, an average weekly mortality of 4.9.

The weekly average for each month was as follows: —

January,	3	July,	4
February,	6	August,	5
March,	8	September,	5
April,	6	October,	2
May,	7	November,	2
June,	6	December,	4

The months having the least mortality per week were October and November. Those having the greatest mortality were March and May.

The mortality per 1,000 deaths from all causes from this disease was 11.1, which was much greater than for the previous years, 1876–1880.

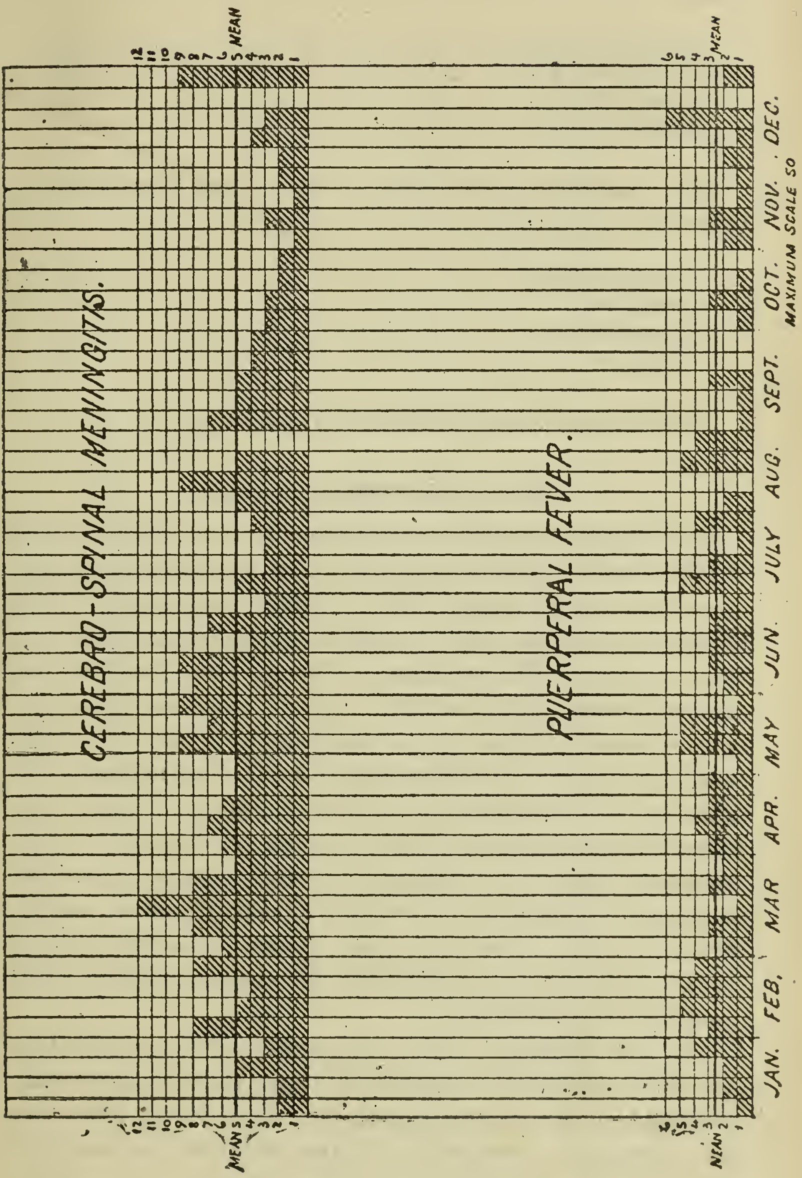
The ratio of deaths per 1,000 of the living population was .23.

The mortality from this disease was much greater than the average of the five years, 1876–1880.

Whooping-cough, Erysipelas, Malarial Fevers, Small-pox.

Reports have been received and records made relative to these diseases, as follows: —

	Total Deaths reported.	Weekly Average.
Whooping-cough,	87.	1 67
Erysipelas,	94.	1.8
Malarial fevers,	25.	.5
Small-pox,	4.	.076


CEREBRO-SPINAL MENINGITIS.
PUERPERAL FEVER.
JAN.
FEB.
MAR
APR.
MAY
JUN.
JULY
AUG.
SEPT.
OCT.
NOV.
DEC.
MAXIMUM SCALE 50
MEAN
1
2
3
4
5
6
7
8
9
10
11
12
MEAN
1
2
3
4
5
6

The mortality per 1,000 deaths from all causes was as follows: —

Whooping-cough,	3.8
Erysipelas,	4.1
Malarial fevers,	1.1
Small-pox,	.1

The mortality per 1,000 of the living population as reported was as follows: —

Whooping-cough,	.078
Erysipelas,	.084
Malarial fevers,	.023
Small-pox,	.0036

Two of these diseases deserve special notice, —

Small-pox and Malarial Fever.

The reported deaths from small-pox, 4, are all that occurred in the State in 1883, and are fewer in number than for any year since 1852, except 1878. There is no disease which presents such remarkable irregularity in its occurrence from year to year. The minimum of deaths was 2 in 1878, and the maximum, 1,029, in 1872. The comparative immunity of the present population, as compared with that of the past century, needs no demonstration in this connection. The influence of vaccination as its chief factor has also been repeatedly shown in the earlier reports of the Board. The constant liability to outbreaks of the disease, especially among the unprotected, should lead Health Boards to watchfulness in this direction. The custom prevailing among many physicians of vaccinating all infants born in their practice is commendable.

The law relating to the vaccination of school-children should be uniformly enforced in every town, since it is a safeguard to the entire community. In proof may be cited the comparative immunity of young children, as compared with their mortality before the introduction of vaccination.

In this connection the following graphic representation from an article by Dr. A. J. Martin * illustrates the com-

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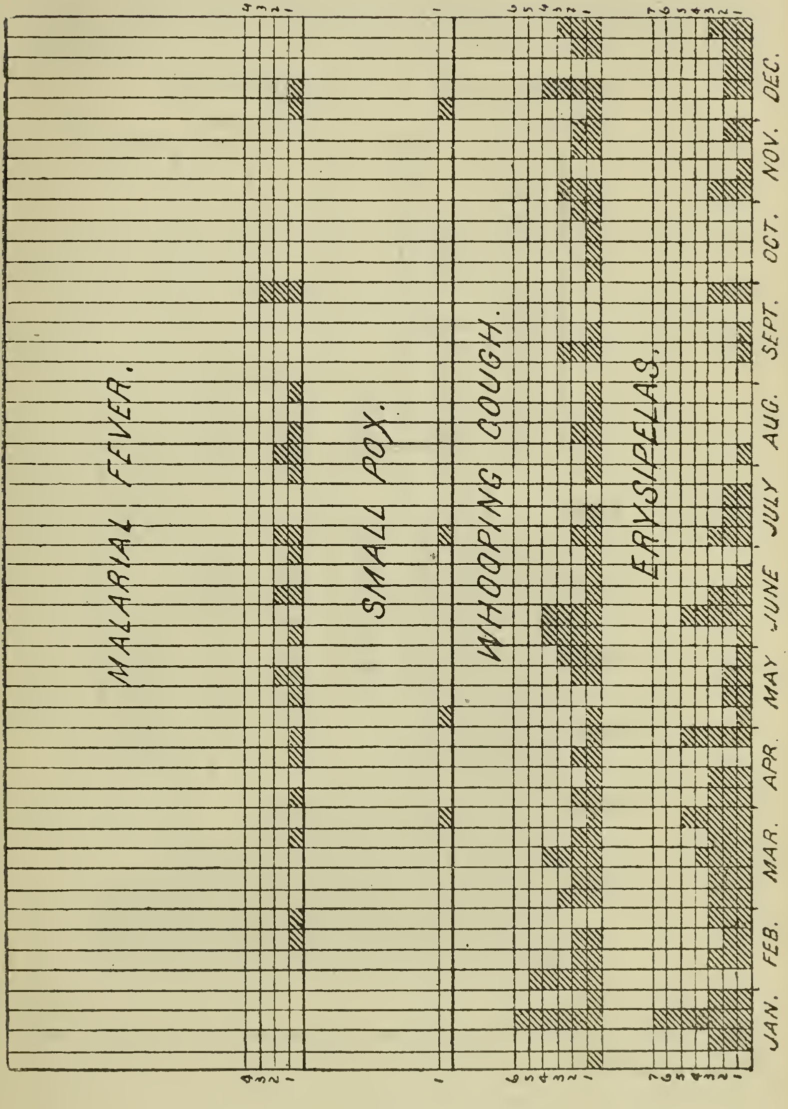
* La vaccination obligatoire. Revue Scientifique, Jan. 1881.


MALARIAL FEVER.
SMALL POX.
WHOOPING COUGH.
ERYSIPELAS.
JAN.
FEB.
MAR.
APR.
MAY
JUNE
JULY
AUG.
SEPT.
OCT.
NOV.
DEC.
1
2
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1
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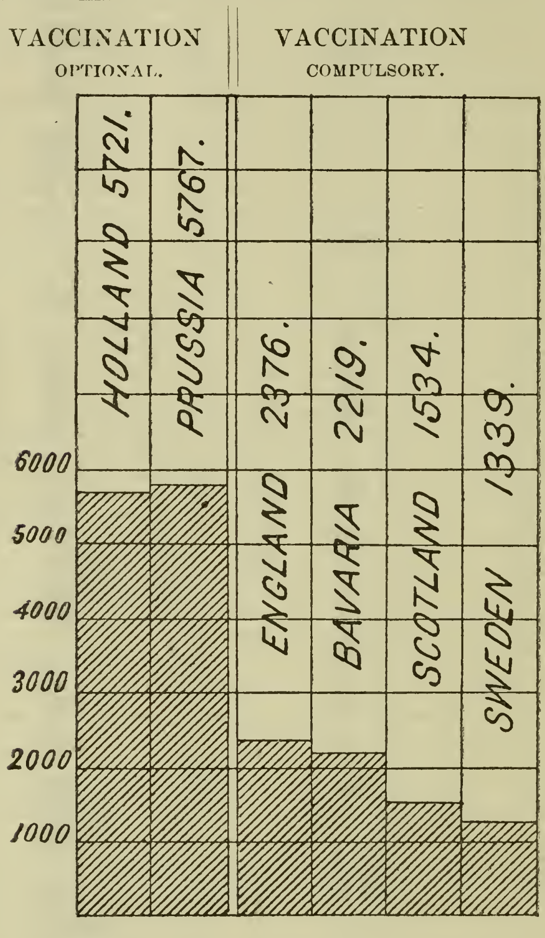
7

parative effect of optional and of compulsory vaccination, as performed in six European countries.

Deaths per Million Inhabitants from Variola, from 1868 to 1873.



During these years there were epidemics of variola in all these countries.

Malarial Fever.

This disease has but little destructive power, even in malarial regions, and especially is this true of Massachusetts. From the few cases which have been annually reported, it may be inferred that the disease has sensibly diminished during the past four years (or since the report of Dr. Adams, of Pittsfield, in 1880).

The total number of deaths reported in the Registration Reports for forty-one years and eight months, ending Dec. 31, 1882, are as follows: —

Ague,	324
Remittent fever,	410
	734

The average per year for the same period is 17.6 for the entire population.

The number returned from the *reporting* population of 1883 is 25. This number may be considerably increased by the complete returns.

The principal area of its prevalence since 1880 has not extended from the region specified in that report; viz., those portions of Hampden and Hampshire counties bordering upon the Connecticut River, together with the Housatonic Valley in Berkshire County. Isolated cases occur, though rarely, in the Eastern counties of the State.

The twenty-five fatal cases were distributed as follows: — Springfield, eleven; Westfield, one; Northampton, one; Fall River, four; New Bedford, two; Brockton, Newton, Westborough, Lynn, Salem and Nantucket, one each.

One case was recorded as intermittent fever; three cases were recorded as malaria; the remaining twenty-one as malarial fevers.

The advantage of a thorough system of registration of vital statistics as an aid to preventive medicine has been repeatedly demonstrated through the registration reports of various countries; notably in the Reports of the Registrar-General of England. A decided lessening of mortality rates has been shown conclusively as a natural sequence of sanitary improvements, chief among which may be named the introduction of pure water-supplies, accompanied with efficient drainage, the control of infectious diseases by means of isolation, disinfection and vaccination, the prevention of food adulteration, the protection of infant life, and the diffusion of sanitary information among the people. The correctness of vital statistics must depend on the individual facts contributed by physicians and others whose duties in this direction are distinctly defined by the Public Statutes.

Habits of accuracy of diagnosis, and a willing compliance with the provisions of legislative enactments, must be recognized as elementary principles, essential to the utility of any system of vital statistics.

General Walker has stated the proposition very concisely: "It is only when it is popularly seen and appreciated, that no one can be born into the community, or die out of it, without affecting the rights and interests of every preceding or surviving member, that adequate legislation and adequate administration will be provided for recording all the essential facts relating to the beginning and the close of every life."

FIRST ANNUAL REPORT

OF THE

WORK DONE IN COMPLIANCE WITH THE STATUTES OF 1882 AND 1883 RELATIVE TO THE

ADULTERATION OF FOOD AND DRUGS.

INSPECTION OF FOOD AND DRUGS.

To the Hon. CHARLES F. DONNELLY,
Chairman of the State Board of Health, Lunacy and Charity.

SIR: — The operations of the Health Department relative to the inspection of Food and Drugs as detailed in the following report, embrace the work done during the year 1883, as provided for by the statutes of that year, and also of 1882.

The reports of the Analysts of Food and Drugs relate to inspection done during the entire year, and those of the Analysts of Milk to inspections made during the last quarter of the year, with the exception of a few analyses made during the previous summer.

A brief summary of the work done was given in the Fifth Annual Report of the Board, pages lxxxiii–lxxxiv. The present report embraces the details of work as presented by the analysts for the same period.

For the purpose of facilitating the work of inspection and analysis, the various substances used as food and medicine are arranged in three groups, as follows: —

1. Food, in general, with the exception of the articles specified in group (2).
2. Milk and its products.
3. Drugs.

Dr. Edward S. Wood had been appointed Analyst of Food during the previous year, and Dr. Bennett F. Davenport, Analyst of Drugs, and in order to carry out the provisions of the statute of 1883, two chemists were added to the number for the purpose of inspection of milk and its products, — Dr. Charles Harrington of Boston and Prof. Charles A. Goessmann of Amherst, with the understanding that the former should conduct analyses of such samples as were obtained in Eastern Massachusetts, and the latter should receive such as were obtained in the four western counties of the State.

In order to obtain a true estimate of the condition of the market, business or trade, whether in the Department of Food or of Drugs, it is obvious that samples of the various articles in these groups must be obtained largely from retail dealers as sold to the consumers. In general, therefore, where there was no reasonable evidence that the retailer was also the manufacturer, compounder or producer of the article in question, and hence his ignorance of the fact of adulteration was either probable or possible, a notice or warning was sent to him in each case of detected adulteration, stating the fact, and calling his attention to the statute and to his liability to prosecution for a second offence, thereby giving the innocent retailer an opportunity to rectify the quality of such goods as are found adulterated.

Food.

In the department of Food inspection the work of the Analyst, as will be seen by the report of Dr. Wood, has embraced the following articles: Milk, Cheese, Butter, Lard, Coffee, Tea, Cocoa, Chocolate, Confectionery, Honey, Sugar, Syrups, Olive Oil, Vinegar, Pickles, Lime Juice, Bread, Flour, Baking Powders and Cream of Tartar.

In nearly all of these classes of food more or less adulteration has been detected, consisting either in a withdrawal of important ingredients, a substitution of cheaper constituents either for a part or the whole, or some other mode whereby the consumer is defrauded. Poisonous compounds, imitations or substitutions on the other hand, or such as are actually injurious to health, are rare.

In addition to the report of the Analysts of Milk which embraces work done from Oct. 1, 1883 to March 31, 1884, the report of the Food Analyst also contains a summary of the work done in the inspection of Milk previous to Oct., 1883.

The General Statute of 1882 relative to Food and Drug inspection, made no special provision relative to any single article of food. In 1883, the act was so amended as to require the expenditure of two-fifths of the appropriation in enforcing the laws against the adulteration of milk. By the act of the present year the appropriation was again increased, the specification changed to three-fifths, and all milk products also were included together with milk.

The acts of 1882 and 1883 were published in the supplement of 1883, pp. xvii–xix.

The following is the amendment of 1884 relative to Food and Drug inspection: —

[Chap. 289, Acts of 1884.]

An Act relating to the adulteration of food and drugs.

Sect. 1. For the purpose of carrying out the provisions of chapter two hundred and sixty-three of the acts of the year eighteen hundred and eighty-two, the state board of health, lunacy and charity may expend annually an amount not exceeding ten thousand dollars: *provided*, *however*, that not less than three-fifths of said amount shall be annually expended for the enforcement of the laws against the adulteration of milk and milk products.

Sect. 2. The state board of health, lunacy and charity shall report annually to the legislature the number of prosecutions made under said chapter, and an itemized account of all money expended in carrying out the provisions thereof.

Sect. 3. An inspector appointed under the provisions of said chapter two hundred and sixty-three of the acts of the year eighteen hundred and eighty-two shall have the same powers and authority conferred upon a city or town inspector by section two of chapter fifty-seven of the Public Statutes.

Sect. 4. Nothing contained in chapter two hundred and sixty-three of the acts of the year eighteen hundred and eighty-two shall be in any way construed as repealing or amending anything contained in chapter fifty-seven of the Public Statutes.

Sect. 5. Chapter two hundred and sixty-three of the acts of the year eighteen hundred and eighty-two is hereby amended by striking out all of section three after the words "person consuming it," in clause (7.) of paragraph (b.) and also by striking out section four, and inserting in place thereof the following: — The provisions of this act shall not apply to mixtures or compounds, recognized as ordinary articles of food or drinks, provided that the same are not injurious to health and are distinctly labelled as mixtures or compounds. And no prosecutions shall at any time be maintained under said act concerning any drug the standard of strength or purity whereof has been raised since the issue of the last edition of the United States Pharmacopœia, unless and until such change of standard has been published throughout the Commonwealth.

Sect. 6. Chapter two hundred and sixty-three of the acts of the year eighteen hundred and eighty-three is hereby repealed.

Sect. 7. Section three of chapter two hundred and sixty-three of the acts of eighteen hundred and eighty-two is hereby amended by adding after the word "therein" in the sixth line as follows: — Unless the order calls for an article inferior to such standard, or unless such difference is made known or so appears to the purchaser at the time of such sale.

Sect. 8. Before commencing the analysis of any sample the person making the same shall reserve a portion which shall be sealed; and in case of a complaint against any person the reserved portion of the sample alleged to be adulterated shall upon application be delivered to the defendent or his attorney.

Sect. 9. This act shall take effect upon its passage. [*Approved May 28, 1884.*

In compliance with section 8 of the foregoing act, samples brought to the analysts for the purpose of examination, are now divided, a portion being reserved and sealed. The application of this requirement to an article of so perishable a nature as milk, is obvious. Scarcely any case of adulteration of milk comes to trial immediately after its detection. The machinery of the courts is such that delay is the rule. A sample of milk is, usually, at least twenty-four hours old when sold to the consumers in the cities of the State. Two or three days elapse in making analyses and forwarding the report of the same, and a still longer time in entering complaint and preparing the case for trial. The original specimen of milk is by that time in a condition entirely unfit for an accurate analysis by reason of decomposition.

MILK.

The statutes of 1883 having provided certain definite requirements relative to the inspection and analysis of milk, as well as the enforcement of the laws relating to its adulteration, special attention has been given to the subject during that portion of the year following the enactment of the law.

The analysts of milk, entered upon their duties Oct. 1, 1883.

Three elements pertaining to the milk supply of the State are of special importance in a consideration of the subject in its general bearing, — *quantity*, *value* and *quality;* the latter being the most essential, as a question related to the public health, while the two former, and especially the first, cannot be ignored in any discussion of the subject.

The figures quoted in this connection are gathered from the United States Census Reports of 1860, 1870 and 1880, and also from the volumes entitled "The Industry of Massachusetts" (1855 and 1865) and the State census of 1875.

Quantity. — The total product of milk of any given State, county or town, must be ascertained approximately and by estimate, since the statistics furnished in the State and national census reports refer in some years to the amounts sold and in others to the amounts produced, and in either case the statistics are probably far within the actual amounts.*

A tolerably just estimate, however, may be obtained by using as factors the average annual yield of a single animal, and the number of milch-cows enumerated by the census, which is, doubtless, not far from the actual number. It should be noted, however, that the number as given in the State census report, refers only to such animals as are kept on farms, and leaves out of the account all cows which are owned singly and not upon farms.

The average milch-cow in a herd of milkers gives milk through about nine or ten months of each year in a series of years. Her annual yield may be stated in round numbers to be six hundred gallons.†

The total product of the United States would, therefore, be (as estimated from the census of 1880, which makes the total number of milch-cows, 12,443,120) nearly seven and a half billion gallons. Of this amount less than one-fourteenth (530 million gallons) is reported as having been sold either as milk for consumption as such, or sent to butter and cheese factories to be converted into those products.*

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* Mass. Industries, 1855 and 1865. Milk sold.
Mass. Census, 1875. Milk produced.
U. S. Census, 1880. Milk sold or sent to butter and cheese factories in 1879.

† Authorities differ widely.
Abl. 1,284 to 2,900 litres = 283 to 640 gallons.
Girard, 2,000 to 5,000 litres = 530 to 1,320 gallons. Report of Director of Paris Municipal Laboratory, 1884.
Blyth, 600 to 700 gallons.
Wilson. Report of Agricultural Exhibition, 1867, 317 to 708 gallons.

For the purpose of comparison certain statistics are here presented relative to the milk supply of Massachusetts as compared with that of the United States as a whole, and also of other States separately, together with the same facts relative to the counties of the State as compared with each other.

The average distribution of the population of Massachusetts is more dense than that of any other State in the Union except Rhode Island. In the immediate neighborhood of large cities, the value of land once used as pasturage and now required for building purposes, together with the increase of the population to be supplied, have compelled the dealers or middlemen to seek larger supplies and at greater distances. Considerable quantities of milk now come to Boston from places fifty or sixty miles distant.

While several carloads of milk come to Massachusetts cities from southern New Hampshire, supplying in part the cities of Boston, Lynn, Lowell, Lawrence and Haverhill, a large amount is also sent out of the State to answer the demand of New York city. Three of the largest milk-producing towns in the State (Great Barrington, New Marlborough and Sheffield, in the Housatonic valley) send a large share of their milk product, daily, to New York.

Providence, R. I , also receives a small portion of her supply from Massachusetts towns in Bristol County.

It may be reasonably inferred that the ratio of milk sold to the number of milch-cows owned in a given State or community, should bear a tolerably definite relation to the density of the population. This proposition is substantiated by the statistics shown in the following tables.

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* The term "Dairy products" as used in the U. S. census reports of 1880, includes "milk sold, or sent to butter and cheese factories in 1879, butter made on farms and cheese made on farms."

These are reported as *Statistics of Agriculture*. In addition to these figures under the head of *Statistics of Manufactures* are found also the following: —

Butter made in factories in census year ending May 31, 1880, 29,421,784 pounds. Full cream and skim-milk cheese made in factories in same year, 215,885,361 pounds.

TABLE I. — FARM PRODUCTS. (*From Census of 1880.*)

STATE.	Population.	Population to square mile.	Number of milch - cows.	Milk sold or sent to butter and cheese factories. Gallons.	Butter made. Pounds.	Cheese. Pounds.	Ratio of milch cows to population.	Gallons of milk sold to each cow.
UNITED STATES,	50,155,783	-	12,443,120	530,129,755	779,250,857	27,272,489	1 to 4	42.
Massachusetts,	1,783,085	221.8	150,435	29,622,953	9,655,587	829,528	1 " 11.8	197.4
Maine,	648,936	21.7	150,845	3,720,783	14,103,966	1,167,730	1 " 4.3	24.8
New Hampshire,	346,991	38.5	90,564	5,739,128	7,247,272	807,076	1 " 3.8	63.7
Vermont,	332,286	36.4	217,033	6,526,550	25,240,826	1,545,789	1 " 1.5	30.
Rhode Island,	276,531	254.9	21,460	3,831,706	1,057,103	67,171	1 " 13.1	179.
Connecticut,	622,700	128.5	116,319	12,289,893	8,198,995	826,195	1 " 5.3	106.
New York,	5,082,871	106.7	1,437,855	231,965,533	111,922,423	8,362,590	1 " 3.5	161.4
New Jersey,	1,131,116	151.7	152,078	15,472,783	9,513,835	66,518	1 " 7.4	101.8
Illinois,	3,077,871	55.	865,913	45,419,719	53,657,943	1,035,069	1 " 3.4	52.4
California,	864,694	5.5	210,078	12,353,178	14,084,405	2,566,618	1 " 4.1	58.
Arizona,	40,440	.4	9,156	42,615	61,817	18,360	1 " 4.4	4.7
Arkansas,	802,525	15.1	249,407	316,858	7,790,013	26,301	1 " 3.2	1.2
Texas,	1,591,749	6.1	606,176	1,296,806	13,899,320	58,466	1 " 2.6	21.
United States factory products, 1880,					29,421,784	215,885,361		
Massachusetts " " "					144,217	1,371,865		

TABLE II. — FARM PRODUCTS. (*From Massachusetts Industries and State Census.*)

COUNTIES.	No. of Milch-cows.			Milk Sold (gallons.)		Milk Produced.	Butter (pounds.)			Cheese (pounds)			
	1855.	1865.	1875.	1855.	1865.	1875.	1855.	1865.	1875.	1855.	1865.	1875.	U.S. Cen's, 1880.
Barnstable, . . .	3,764	3,592	1,211	-	91,425	263,047	194,327	42,306	69,980	1,325	720	-	50
Berkshire, . . .	18,096	17,609	15,527	-	76,827	3,472,084	1,262,845	525,756	1,273,462	2,658,192	1,641,203 80,000	460,817	240,097
Bristol, . . .	9,306	8,749	7,502	154,758	1,047,375	2,531,408	333,853	168,464	279,053	79,633	22,706	7,958	5,584
Dukes, . . .	764	706	552	-	16,189	78,347	28,382	14,729	15,416	3,987	1,554	70	705
Essex, . . .	11,799	11,864	9,151	452,984	1,267,922	2,960,538	533,853	205,505	348,607	80,063	22,477	16,288	6,070
Franklin, . . .	9,501	8,622	10,271	-	56,198	1,093,209	884,307	464,169	1,285,048	233,337	106,484	63,711	46,356
Hampden, . . .	9,731	10,506	9,891	98,321	411,443	2,941,463	729,637	352,866	783,879	381,721	314,337	105,761	82,547
Hampshire, . . .	10,062	9,587	9,806	-	151,817	2,581,034	931,295	411,825	1,149,077	336,015	184,135	87,856	65,316
Middlesex, . . .	22,563	22,302	20,244	1,077,271	3,111,318	7,755,151	838,748	415,339	517,036	72,695	14,601	8,591	7,728
Nantucket, . . .	548	449	376	-	10,831	37,847	24,152	14,436	26,985	-	-	-	-
Norfolk, . . .	9,995	9,610	5,743	646,101	1,139,121	1,945,750	316,254	144,483	163,147	42,277	11,271	2,139	2,015
Plymouth, . . .	8,004	7,931	5,006	30,310	254,115	1,565,945	399,878	195,797	362,276	82,501	27,264	16,208	9,378
Suffolk, . . .	519	453	496	119,055	83,175	172,565	500	-	4,583	-	-	70	-
Worcester, . . .	33,917	31,306	30,258	722,116	2,320,615	8,299,771	1,637,978	840,115	1,643,882	1,791,030	1,120,999 304,841	510,765	363,682
Totals, . . .	148,569	143,286	126,034	3,300,916	10,038,372	35,698,159	8,116,009	3,795,790	7,922,431	*5,762,776	†3,852,592	‡1,280,234	§829,528
Values, . .	-	-	-	$755,887	$1,930,409	$5,934,671	$1,678,577	$1,389,027	$2,747,878	$464,250	$853,045	$162,826	-
Data for 1845. Total amount, ...				2,800,412	-	-	7,688,566	-	-	7,262,637	-	-	-

* Including factory cheese.

† Including the product of 5 cheese factories in Berkshire and Worcester Counties.

‡ Farms only. Factory product for 1875, 1,786,783; total cheese for 1875, 3,067,017. Factory product for 1880 1,371,865.

§ Farm product.

TABLE III. — *Tables showing the reported Products of Certain Milk-producing Towns for the Years 1855–65.*

TOWNS.	MILCH-COWS.			MILK SOLD (gallons.)			BUTTER (pounds.)			CHEESE (pounds.)		
	1855.	1865.	1875.	1855.	1865.	1875.	1855.	1865.	1875.	1855.	1865.	1875.
BERKSHIRE COUNTY.												
Great Barrington,	662	787	803	-	6,195	175,955	75,000	32,290	83,045	3,500	3,816	9,320
New Marlborough,	1,069	1,202	1,357	-	252	472,808	65,000	53,655	81,672	50,000	233,933	51,670
Sheffield,	1,465	1,134	1,392	-	1,036	295,005	165,225	48,620	90,017	179,890	82,345	13,445
Williamstown,	1,052	816	956	-	-	28,362	46,665	15,822	75,133	172,650	119,628	3,715
MIDDLESEX COUNTY.												
Concord,	1,075	727	939	-	217,017	441,029	11,080	3,483	9,005	1,200	-	-
Groton,	782	750	769	-	63,681	202,270	42,000	13,386	29,895	3,840	-	380
Lexington,	1,090	808	973	350,846	148,837	510,551	400	500	3,379	100	-	-
Weston,	463	534	615	40,000	119,876	291,361	26,300	10,430	4,874	-	100	-
WORCESTER COUNTY.												
Barre,	1,587	1,537	1,347	-	8,597	76,605	35,700	38,386	57,376	323,830	323,584	81,306
Harvard,	917	840	927	163,150	172,108	345,323	43,730	15,582	18,554	1,350	275	50
Sutton,	713	619	519	14,655	4,856	179,714	67,100	26,740	42,667	25,573	15,632	7,209
Westborough,	897	885	966	193,736	237,422	451,591	20,779	6,356	9,037	2,325	401	192
Worcester,	1,297	1,130	1,233	241,508	255,335	611,712	39,626	21,165	21,364	9,650	-	290

These tables, I., II., III., will also serve to show, in a comparative manner, the importance of the milk supply of Massachusetts as a food product, compared with that of the United States in general and also with that of Eastern, Western and Southern States. The State returns for the earlier years, 1845, '55 and '65, must be regarded as incomplete; no returns being given in the case of some counties as to the amount of milk sold.

The number of milk-producing animals in each of the census reports is taken from actual count. It is notable that this number has not kept pace with the population, but has remained nearly stationary; the aggregate number for 1880 being but little larger than that of 1850.

The summary at intervals of five years is as follows: —

Milch-cows kept or owned on farms in Massachusetts: —

1850,	130,099	= 1 to 7.6 inhabitants.
1855,	148,569	
1860,	144,492	
1865,	143,286	
1870,	114,771	
1875,	126,034	
1880,	150,435	= 1 to 11 8 inhabitants.

The ratio of milch-cows to the population is less than in any other State, with one exception, and has steadily diminished from one cow to 7.6 inhabitants in 1850, to 1 in 11.8 in 1880.

The columns relating to total amount of milk should not be misunderstood, and the great discrepancy in the statistics has already been explained.*

While the ratio of milk sold, to the population is apparently not nearly as large in Massachusetts as in some other States, in consequence of the relatively smaller amount converted into butter and cheese in the former, on the other hand the ratio of milk sold, to each milch-cow owned or kept, is much greater than that of any other State.

There has undoubtedly been a great increase in the relative consumption of milk as food within the past twenty years. Hotel-keepers, proprietors of restaurants, boarding-houses and other places where milk is retailed, unanimously testify that the demand for fresh milk to be used as a beverage is much greater at present than in former years.

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* Page 95.

The statistics relative to butter and cheese in Tables I. and II. are undoubtedly more nearly correct than those relating to milk. They show that the product of butter has not been largely affected by the increased demand for milk, while the cheese product has been decidedly diminished, the amount having fallen off from 7,262,637 pounds in 1845 to 3,067,015 pounds in 1875 (including factory and domestic products) and 2,201,393 pounds in 1880.

Table III. is introduced to illustrate as well as is possible from the incompleteness of the returns, the variations in the product of certain farming towns in large milk-producing regions, as well as the varied importance attached by certain localities to the value of their milk products. In these towns, while the number of producing animals has shown but little variation from the date of one census to that of another, there is a very marked difference in the reported amounts of milk and of cheese sold or produced. In the case of milk, as in the general returns in Tables I. and II., the variation is also more apparent than actual. In the case of cheese the variation is real, and is due to the actual decrease in manufacture, from the withdrawal of the milk for the purpose of sale in its fresh condition.

Quality. — The foregoing statements as to the *quantity* of milk produced in Massachusetts form a fitting introduction to the subject of *quality* of the supply. And as a reference to the report of the analysts will show, the average quality of the milk furnished by the cow in Massachusetts showed a marked difference in 1883 from that retailed to customers, in the large cities of the State.

The statute of 1880 prescribed that milk as sold in this State shall contain not less than 13 per cent. of solid residue. Without further comment upon the standard, the following results are found from analyses made of milk obtained in the different cities of the Commonwealth up to Jan. 1, 1883: —

Boston: 162 samples averaged	11.04
18 only were above the standard of 13.	
The lowest showed	7.3
Chelsea: 10 samples, average,	11.32
Lowest,	6.1
Charlestown: 14 samples, average,	10.33
Lowest,	8.
Cambridge: 18 samples, average,	11.7
Lowest,	10.
Lowell: 10 samples, average,	11.5
Lowest,	9.70
Lynn: 10 samples, average,	11.78
Lowest,	9.
Lawrence: 10 samples, average,	13.42
Lowest,	10.40
Somerville: 6 samples, average,	10.6
Lowest,	9.85
Worcester: 12 samples, average,	13.41
Lowest,	10.40
Springfield and its neighborhood: 23 samples, average,	12.77
Lowest,	10.35
Holyoke and its neighborhood: 16 samples, average,	12.85
Lowest,	11.06
Cities of Eastern Massachusetts: 254 samples, average,	11.31
Western " 51 " "	12.95

These do not include a considerable number of analyses made of milk taken directly from the cow and known to be pure.

The quality of milk as *produced* by the cow is a theme for the consideration of the sanitarian as well as of the agriculturist. Briefly, however, it may be said to be modified by the following causes or conditions: —

1. Age. 2. Breed. 3. Season of the year. 4. Time since calving. 5. Feed. 6. Care and treatment in stables and out, including ventilation, water supply and drainage, and general sanitary care of herds.

The two latter items have special sanitary importance, and while it is true that a chemical analysis will show whether a given sample of milk is adulterated or not (or, in other words, whether it has been skimmed or watered) it must be acknowledged that the resources of chemistry do not yet furnish the required information as to whether still more important indications have been fulfilled. A sample of milk may conform to the requirement of the statutes as to its amount of total solids; it may yield a fair amount of cream and other milk solids and yet be utterly unfit for use as food.

The experience of the present year has shown that a sample of milk produced by a herd of cows under the following conditions came fairly up to the required standard of 13 per cent. of solids: —

1. A herd of cattle largely selected from condemned animals at extremely low prices.
2. Overcrowding.
3. Filthy stable with filthy surroundings.
4. An extremely impoverished diet, malt (brewer's grains and sprouts) tomato skins and small quantities of salt hay, and bale hay and meal.
5. Filthy water, pumped from a well driven through a pool of liquid manure under the stable.

Analysis of Water furnished to these Cows: in parts per 100,000.

Ammonia.	Alb. Ammonia.	Chlorine.	Residue.			Hardness.
			Fixed.	Volatile.	Total.	
0.0650	0.0232	2.85	15.3	7.5	22.8	5°

When it is known that even a slight change in a mother's diet will have an immediate and unfavorable effect upon the nursing infant, is it possible that milk elaborated under the conditions existing in the dairy just described can be fit for the delicate stomach of the new-born infant?

Something more than chemical analysis is requisite for the protection of that part of the population which is largely dependent upon cows' milk for their nourishment. A thorough inspection of the stables, the feed, the water-supply and drainage is necessary for the cure of such evils.

The practice of feeding milch-cows with partially decomposed food, such as the refuse products of distilleries and breweries and the waste material of canning establishments is a questionable one. Too often does the desire to secure an abundant flow of milk lead the milk-producer to adopt modes of feeding which cannot be too severely condemned.

Cheaper sorts of fodder, largely the malt of breweries, and containing comparatively small amounts of the nutritious elements necessary for milk production, are now extensively used for the feed of milch-cows in the neighborhood of Boston and other large cities.

In regard to the use of malt or brewer's grains, Prof. Girard, Director of the Paris Municipal Laboratory, in an excellent paper upon the Feed of Milch-Cows, says: "They should be condemned by all milk producers who desire to furnish healthful and nutritious milk."*

The same writer in conclusion, says: —

1. The udder cannot be considered as a filter so perfect in its nature that water charged with poisonous ingredients becomes harmless and healthful in its passage through it.

2. Every substance which contains a noxious element, germ, microbe or poison capable of mingling with the blood, should be absolutely removed from the feed, since the milk being derived directly from the blood, everything which passes into the latter may also reappear in the milk.

3. The industrial residues known as malt seem to have a bad effect upon the quality of the milk, especially when they are employed exclusively and in too great a proportion for the feed of milch-cows.

In Hamburg, the establishment of several model stables where the cows are kept under the most favorable conditions and supplied with fodder selected with special reference to the production of milk of the best quality, has resulted in a decided decrease of infant mortality.

The forcing plan, whereby an animal is tied up throughout the year and compelled to eat food which she invariably loathes at first, makes of her a mere milk-machine, and the production of a healthful flow of milk becomes an impossibility.

A farming town of small population, not twenty miles from Boston, has had usually several hundred cows feeding in its pastures and supplied with the best of fodder both in the stable and out. For more than fifty years, cholera infantum was unknown in the town and infants rarely died within their first year of life. Recently the march of population has encroached upon its borders and the pasturage has become considerably curtailed, while the number of cows to supply the demand of neighboring populous towns has increased. As a consequence, in many instances, brewers' grains and other artificial kinds of feed or industrial residues have been introduced for milk-production. Within the past few years cholera infantum has become quite common in this town.

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* La Nourriture des Vaches laitières, et son influence sur la composition du lait, par M. Ch. Girard, Directeur du Laboratoire Municipal. — *Revue d'Hygiene. May 1884.*

A radical change is needed in a great number of the cow-stables throughout the State, not only as to the feed, but in the matter of ventilation, of lighting, of overcrowding and air-space, cleanliness, water supply and drainage. Too often does it happen that the water used for drinking purposes for the cattle and also for washing the cans, and possibly for diluting the milk, is obtained from a well in the barn-yard or cellar into which drains the sewage of the manure-heap.

The *quality* of the milk as *sold to the consumer* is also variously affected by the following causes, which may be considered as increasing the liability to its adulteration : —

1. The density of population.

2. The limited number of milk-producing animals and hence a comparative scarcity of supply.

3. The distance of the producer from the consumer.

4. The increase in the number of middlemen (*e. g.*, dairymen, shippers, contractors, milk-peddlers, grocers and bakers).

5. The length of time elapsing between production and consumption.

6. The want of efficient inspection.

7. The dishonesty of manipulators.

The first cause named, *density of population*, though not of itself a direct cause, is found to be applicable everywhere in large cities.

In Eastern Massachusetts, as the analyses of the Board will show, milk adulteration is much more common than in the western portion of the State. Boston and the immediate suburban cities in its neighborhood furnish abundant samples of milk which do not conform to the required standard, while cities lying at a greater distance in the midst of a milk-producing territory not so densely populated, like Lawrence, Worcester, Haverhill and Newburyport, are more free from the criminal practice. In some of these, the presence of an efficient local inspector has doubtless contributed largely to a pure supply.

The ratio of producing animals to the population has already been shown to be far below the average of New England and also of the United States. The actual number has also increased but little for thirty years. This fact, in connection with an increased demand, both relative and absolute, has more than doubled the inducement to dishonest action.

The distance of the producer from the consumer, the increase in the number of middlemen, and the length of time elapsing between production and consumption, are three causes which are intimately associated, the third being a natural consequence of the first and second.

No food-product subject to analysis is so perishable as milk. Hence, the nearer the consumer approaches to the producer, both in time and in distance, the greater is the probability of his obtaining a fresh and pure supply. Every mile of travel and every hour's delay makes the probability of impurity and adulteration greater.

The influence of an increased number of middlemen has been recently illustrated by the frequent analyses of the Board. The milk of a dairy near Boston was found to have 13. of total solids; on the same date a sample was obtained of a milkman supplied from the same farm whose milk was found to contain 11.37 of solids, and another sample taken from a grocery supplied by the milk-peddler had but 9.84 of total solids, representing an addition, respectively, of about fifteen and twenty-five per cent. of water.

Hence the advantage of combination and organization on the part of producers for the purpose of placing themselves in direct communication with the consumers for the benefit of both parties, both as a matter of pecuniary advantage to both and also as a prevention of adulteration. Such associations have proved successful in England and also in the State of New York. The Aylesbury Dairy Company of the

West End of London, the Holland Park Dairy of Kensington and the Onondaga County Milk Association of Syracuse, N. Y., are examples of great organizations which have successfully solved the problem of coöperation and won the confidence of producers and consumers. Labor and the cost of delivery are greatly economized, a high standard of milk is maintained, and the milk sold at a reasonable rate.

Such combinations, under good management, deserve public encouragement.

The prime importance of milk as an article of human food is universally recognized. The facility with which its adulteration is systematically practised in many of the large cities of the State, renders a careful supervision of its sale necessary. Such adulteration cannot be regarded in the light of a mere commercial fraud like that which is practised in the case of many other classes of food where ingredients of considerable food value, though commercially inferior, are substituted either in part or as a whole. The adulteration of milk is systematic robbery of a twofold nature; first, the removal of a most valuable part, the cream; and second, the substitution of water for another part.

Thousands of helpless infants in the cities and large towns of the State are deprived of the mother's milk, and must depend upon that of the cow as the first and most common substitute. It is therefore important, not only for this purpose, but also for its use as a valuable part of the household food supply, that the consumer should receive it in the same pure and undiluted condition in which it is produced by the animals from which it is taken.

The reports of the analysts of milk will show the condition of milk as it is found on inspection of the supply of the chief cities of the State.

The chief point to be noticed is the marked prevalence of adulteration in the city of Boston and in its immediate neighborhood. The western cities of the State appear to be much more free from the practice of fraud so far as is shown by the inspection of the past year.

The prosecutions conducted under the statutes relative to the prevention of milk adulteration during 1883, have already been detailed in the General Report issued in January.

The practice of issuing warnings to offenders who were found on inspection to have sold adulterated milk, has proved quite successful in its operation. Many instances having occurred in which milk taken from parties who had once been warned was found to meet the requirements of the statutes as to purity. The object of this warning, as has already been stated in the General Report of the Board, was to enable parties who are purchasing milk at second-hand to know the quality of the article in which they are dealing, in view of their possible ignorance as to its quality.

Drugs.

The various substances used as medicine are sold throughout the State by manufacturers, wholesale druggists, apothecaries, physicians, and also a few of the more common articles by grocers. The number of manufacturers in Massachusetts is not large.

The inspection of the year has embraced, mainly, the more important articles known as officinal drugs, the standard of which is prescribed by the United States Pharmacopœia.

In the case of drugs sold in original sealed packages and not manufactured by the retailer, a warning notice has been issued as already referred to under the topic of Food. It is the custom of many retail druggists, however, to manufacture many of the simpler forms of medicine such as Tinctures, Syrups, Spirits, etc. In the case of such of these as showed a considerable departure from the prescribed standard, and the evidence was clear, complaints were entered in the courts.

In the case of Tincture of Opium, in which a slight change or increase in strength was made by the standard of 1880 from that of 1870, care was taken that no complaint should be entered against any one whose preparation conformed even to the lowest of the two standards.

The article in question is a very important preparation. Its uses as an article of materia medica are universally recognized, and a standard strength should be maintained between certain well-defined limits. These limits for the Tincture of Opium are 1.2 per cent. of morphia as a minimum and 1.6 per cent. as a maximum. The report of the analyst shows a very wide divergence from these figures, scarcely any samples assaying with a result above the maximum and a large number below the minimum required by the statute.*

Certain preparations or pharmacopœial compounds containing Quinia have also been found to differ very much from the requirements of the statute, and the effect of their sale is often to disappoint the physician who prescribes them in their anticipated action upon his patients.

Suppose a chemical salt to be sold which is believed to contain a definite proportion of a certain valuable drug. On analysis, it is found to contain one-half only of the required amount of the drug in question. The effect of such a drug is unfortunately to defraud the patient, to disappoint the prescriber and possibly to render him sceptical as to the therapeutical value of the drug. The retailer in such a case may not be at fault. He cannot be expected to make an analysis of every drug which he sells. The statute, therefore, in this instance protects the people, the retailer and also the honest manufacturer, whose business is injured by the ruinous competition of unprincipled neighbors.

The enactment of the statutes of 1882 and 1883 has been followed in Massachusetts by greater accuracy in the preparation of chemical drugs; and in the case of many drugs which are prepared in other markets outside of the State, greater care is now taken in consequence of the requirements of the statutes relative to such preparations as are sold in Massachusetts. Assayed drugs sold at a definite strength, as in the case of powdered opium, are recognized as an important feature in the drug trade. In some cases manufacturers doing business outside of Massachusetts, have requested the return of all preparations which do not conform to the standard of the United States Pharmacopœia.

As the report of the Analyst of Drugs will show, there has been in some directions a great lack of accuracy in the making of pharmacopœial preparations, the error being almost invariably on the side of deficiency and not on that of excess of essential constituents.

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* By the Pharmacopœia of 1880 (page 455) this increase amounts to 11.1 per cent. only, a change so slight as not to be recognized by the new National Dispensatory in its statement of the dose of Tinct. Opii.

The difference would be only 2 drops and a slight fraction in the ordinary dose of 20–25 drops of laudanum.

There are a large number of drugs which in the process of manufacture either acquire or retain, as a part of their original composition, slight traces of impurity which cannot be said to be the result of carelessness or of intentional fraud.

Since absolute purity or perfection in such cases would involve a greatly increased expense, as in the case of some of the bismuth and potassium compounds, it would appear reasonable to make an exception in their favor within certain well-defined limits.

The drugs submitted to the analyst, have, as in the case of food, been carefully examined, each sample having been separately analyzed and the result of the analysis recorded. These chemical analyses are very different from simple cursory inspections and represent a great amount of chemical work.

The same is true in regard to the work upon milk and its products. The custom of past years has been to place too much reliance upon simple inspections with the lactometer, which in themselves are almost worthless, except in the grossest cases of fraud.

REPORT OF THE ANALYST OF FOOD.

Prof. Edward S. Wood, M. D.

REPORT OF THE ANALYST OF FOOD.

BOSTON, MASS., January, 1884.

Dr. S. W. ABBOTT, *Health Officer*,
State House, *Boston*, *Mass.*

DEAR SIR: — I have the honor to present my report on the examination of foods for the past year. About six hundred samples were received and examined; of these nearly one-half were adulterated. I have noticed during the year a gradual improvement in the character of the samples; among other things it may be remarked that many of the brands of ground spices, which were sold in the early part of the year as "strictly pure," are now marked "compound." It appears that many of the common articles of food, notably the cereals, are quite free from fraudulent adulteration.

Respectfully yours,
EDWARD S. WOOD, M. D.

MILK.

Milk, which is one of the most important of foods, and, in fact, to infant life *the* most important, is unfortunately the one most commonly adulterated. It is true, indeed, that deleterious substances are rarely added for purposes of adulteration, but it is also true that the abstraction of the cream and the addition of water are practices by which the fluid loses much in nutritive value. Since it is upon milk that the vast majority of bottle-fed children are nourished, it is of the utmost importance that the milk supply should be kept free from those practices which lower its value as a food. There exists everywhere, but chiefly in cities, a tremendous mortality among children under one year of age, and this mortality is by far the greatest among those which are fed with the bottle. The death-rate of breast-fed infants is about 10 or 15 per cent. ; of bottle-fed infants it is from 60 to 80 and more. A great factor in the causation of this tremendous mortality is the inability of the poorer classes to obtain pure milk, not so much on account of being unable to pay for it, but more because of the extremely common practice of watering and skimming. From observation of the prices paid for the samples which have been examined, it is evident that the price is no criterion of the quality of the milk. Hence the poorer classes, whose source of milk supply is as a rule the retail shops, are quite likely to pay the price of good milk for a very inferior article. It is true that in feeding children on the bottle the milk is diluted and then sweetened in order to make it approximate the character of woman's milk, but the mother who buys her milk at the corner grocery or bake shop does not know that the milk is already watered and proceeds to re-dilute it for her child. The child sickens, becomes weak from digestive disturbances and malnutrition and dies, and its death is only too often attributed to the pent-up streets, unwholesome surroundings, and impure air of the city. A comparison of country-bred with city-bred children is always, or at least as a rule, in favor of the former and it cannot be due entirely to the purer air of the country nor to improved hygienic surrounding, but must be in part attributable to the purer milk which is there obtainable. No one will question the fact that country milk is purer than that article, which, passing through several hands, is finally sold to the consumer in a condition much the worse for wear at many if not most of our retail shops. During the past year the writer has had occasion to examine about a hundred samples, a number of which were obtained direct from the milkman. These latter were usually found to be good milks, which result cannot be said to apply to those purchased in the shops. I would not imply that all shops retail adulterated milk, but I can say with safety that a majority of those visited in the cities do sell such milk habitually. Prosecutions under the law have been begun and several convictions have been obtained, and it is hoped to break up the reprehensible practice to a very great extent by active work in this direction.

Composition of Milk. — According to Blyth the average composition of milk is as follows : —

Fat,	3.50
Casein,	3.98
Albumen,	0.77
Milk-sugar,	4.00
Ash,	0.70
Water,	86.87

The mean of 377 analyses compiled by König, gives the following figures : —

Fat,	3.65
Casein and albumen,	3.41
Milk-sugar,	4.81
Ash,	0.71
Water,	87.42

From a great number of analyses it has been observed that the total amount of the milk solids less the fat in pure milk varies from 9 to 11 per cent. When the amount of solids not fat falls below 9 per cent., or that of the fat falls below 2.50, it is most probable that the milk is not pure.

Adulterations of Milk. — The adulterations of milk other than water and the abstraction of the cream are comparatively uncommon. Among those mentioned are the addition of cane sugar to conceal watering, and of salt, salicylic acid, and borax to prevent decomposition. The addition of chalk and calves' brains exists only in the popular imagination. All of the adulterations above mentioned are easy of detection.

Analysis of Milk. — A complete examination of milk, embraces the estimation of the fat, albuminoids, sugar, ash and water, besides examination with the microscope and observation of the specific gravity. The latter has alone but little value, since a very poor milk may without difficulty be made to possess the normal specific gravity. The specific gravity of pure milk is about 1.029 to 1.034, though a milk which is exceptionally rich in fat may fall lower. The removal of fat (skimming) sends the specific gravity to 1.0325 — 1037. By addition of water to the milk already poor in fat, the specific gravity may be lowered to that of the normal fluid, and the vendor has not only a certain amount of cream, but more milk than he originally possessed, and the milk, if judged of by specific gravity alone, passes as normal.

Under the present law no milk shall be sold which contains less than 13 per cent. of *total* solids, and for the carrying out of the law no extended analysis is necessary beyond estimating the relative proportion of total solids and water, with of course special investigation of samples suspected of containing substances foreign to milk. The determination of the total solids is made by evaporating the water from a weighed amount of milk in a weighed dish; the residue represents the total solids and the difference in weight the water.

Examination of the samples received. — I received during the past nine months 96 samples; the results obtained are tabulated below: —

Average percentage of solid matter,	10.94
" " " water,	89.06
" " " fat,	2.63

Number of specimens containing above 15 % solids,					2
" " " " between	14	and	15 %	solids	2
" " " " "	13	"	14 %	"	7
" " " " "	12	"	13 %	"	10
" " " " "	11	"	12 %	"	19
" " " " "	10	"	11 %	"	31
" " " " "	9	"	10 %	"	20
" " " " "	8	"	9 %	"	4
" " " " "	7	"	8 %	"	1
			Total,		96

Of the whole number received but eleven reach the standard fixed by law — 13 per cent. total solids. The cases which have been selected thus far for prosecution are those whose percentage of solids has been very low.

CHEESE.

The adulterations of cheese are not numerous. Among those mentioned are starches, lard, oleomargarine, soapstone and potash, besides several of the metallic poisons which are sometimes used as preservatives or wrappers, or to give the appearance of age. The coloring matters which have been used from time immemorial (annatto, etc.) are harmless and cannot be considered as adulterations. Borax, saltpetre and alkaline carbonates, are sometimes used as preservatives. Cheese consists of casein, fat, milk-sugar, water and salts. Owing to the various methods of manufacture, and to the variety of milks used, there can be said to be no fixed standard for the relative proportions of the above-mentioned constituents.

Poisonous Cheese. — Cases of poisoning apparently due to cheese are of somewhat frequent occurrence. The exact nature of the poison is unknown, but it is probably an alkaloidal substance produced by abnormal ripening. It has also been suggested that the poison may be derived in some cases from the food of the cows from whose milk the cheese is made. The symptoms observed in these cases are usually those of irritant poisons, but the cases, as a rule, if not always, end in recovery.

The adulterants of cheese are detected by their appropriate tests. The analysis of the so-called poisonous cheeses is a process which is as yet to be discovered.

Seven samples of cheese were received from various sources, all of which were said to have caused poisonous symptoms. The results of the examination were, owing to our at present very imperfect knowledge concerning the poison, entirely negative.

No samples were received to be examined for adulterations.

BUTTER.

Butter consists chiefly of the fat of milk with more or less water, casein, milk-sugar and salts. The pure butter fat is a mixture of the glycerides of palmitic, stearic and oleic acids, together with the glycerides of certain soluble and volatile fatty acids — butyric, capric, caproic and caprylic acids. Good butter should contain at least 80 per cent. of butter fat. The amount of water in genuine butter is very variable. Hassall, Parkes, Hehner and others, give 5 to 10 per cent. as the ordinary limits; Fleischmann says it never contains more than 18 per cent.: Griessmayer allows from 8 to 15 per cent. König gives 11.7 per cent. as the amount in good unsalted butter. The amount of casein may vary from 0.19 per cent. (the minimum observed in 89 analyses collected by König) to 6 or 7 per cent.; Blyth gives 2.5 per cent. as the average amount. The higher the proportion of water and casein in butter, the more quickly will the butter become rancid. The milk-sugar is present only in small amount; in the 89 above-mentioned analyses the minimum was 0.13 and the maximum 1.11 per cent. The salts contained in butter consist chiefly of common salt, which is added to preserve it, and calcic phosphate.

Adulterations. — Among the articles mentioned as adulterants of butter are clay, flour, alum, borax, baric sulphate, soapstone, chalk, silicate of sodium, starch, olive oil, rape oil, cottonseed oil, palm oil, cocoa butter, lard, oleomargarine, salt and water. All of these excepting the cheap fats and water are rarely used, and they are not of sufficient importance to deserve more than passing mention.

Oleomargarine stands first in importance as an adulterant of butter. Oleomargarine butter was first produced by Mége-Mouriès, a French chemist, who, several years before the Franco-German war, was commissioned by Napoleon III. to experiment with a view to the discovery of a cheap butter for the army and navy. It appeared first in commerce in 1872. The process discovered by Mége Mouriès is, with a few modifications, the one in present use, and is briefly as follows: — Beef fat, washed and "hashed," is heated to 45° C. (113° F.) in large tanks. The fat melts to a yellow oil which is strained through linen bags. The filtered product is then mixed with about two parts of salt per hundred, and the mass is kept for about a day at a temperature of from 20° to 25° C. (68°–77° F.) The stearine meanwhile crystallizes out, but the oleomargarine having a lower melting point remains fluid. The latter is separated by hydraulic pressure and allowed to cool and solidify. At this stage the product is tasteless and with no flavor of butter. It is then churned with milk (100 lbs. of fat to about 25 quarts of milk) colored with annatto, then suddenly chilled, and worked into lumps.

Comparative Analysis of Genuine and Artificial Butter (Mège Mouriès.)

	Genuine.	Artificial.
Water,	11.968	11.203
Solids,	88.032	88.797
	100.000	100.000
SOLIDS.		
Insol. fats,	75.246	81.183
Sol. fats,	7.432	1.823
Casein,	0.182	0.621
Salt,	5.162	5.162
	88.032	88.797

The higher proportion of soluble fats in the real butter constitutes the chief difference between the two. Oleomargarine contains as a rule less water and but little casein, and it is owing to the relatively small amounts of water, casein, and soluble fats present, that the product does not become so rapidly rancid, and hence has the advantage of keeping longer.

In Oldenzad (Holland), according to Griessmayer, a very good artificial butter is made from milk and olive oil.

Water as an Adulterant. — Besides the water contained normally in butter a large amount can be worked in by kneading, or by stirring the butter in water. The addition of salt in considerable amount enables the butter to hold more water.

Angell and Hehner met with two samples of butter containing respectively 23.981 and 42.358 per cent. of water. Alex Müller and Eisenstuck found 23.47 per cent., N. Gräger met with a sample containing 28.75 per cent., and König and C. Brimmer one containing 35.12 per cent.

Examination of Butter. — For analysis simply for adulterations it suffices to proceed in the following manner: — In a tall narrow weighed cylinder place 50 grammes of butter; add 110 c.c. of warm distilled water, shake well until the butter is dissolved, close with a cork, and invert in a bath of water at 50° C. Let stand about two hours at this temperature, then remove and let it slowly cool. When the butter fat is completely solidified remove the cork and allow the water, casein, and salts, etc., to escape. The difference in weight gives a tolerably exact estimate of the amount of pure butter fat in the sample. The watery extract is then filtered; the residue will contain casein and such possible adulterations as starch, chalk, heavy spar, gypsum, etc., which may be detected by the usual tests; the filtrate may contain common salt, alum, borax, salicylic acid, etc., which may also be detected by the appropriate tests. The butter fat which is left in the cylinder is to be examined for the foreign fats according to methods which will be mentioned later.

To estimate the amount of water heat a weighed amount cautiously in a weighed evaporating dish over a free flame till it ceases to lose weight. Care must be taken to constantly stir the mass while heating until all the water is expelled. The dish with the butter is again weighed (after cooling) and the difference between the two weights represents the amount of water.

Examination by the Microscope will reveal the presence of starches, etc., and if the butter has been mixed by fusion with any fats and slowly cooled, crystals will be readily seen. The presence of such fat crystals is good ground for suspicion. On the other hand the absence of such crystals is no proof that the butter is genuine, since oleomargarine butter is so rapidly chilled after the churning process that the crystals are prevented from forming.

Examination of the Fat.—This is the most important part of the analysis of butter since the introduction of foreign fats is the most common adulteration. The specific gravity and melting point tests are of very little importance and are tests upon which very little reliance can be placed. Microscopic examination has been already mentioned. There are various qualitative tests which have but little value and it is hardly worth while to enumerate or describe them. The only safe and reliable investigation of the fat is the quantitative chemical analysis of the fat freed from casein, water, salts, etc. The processes used depend upon the fact that butter fat contains besides the glycerides of the insoluble acids, oleic, palmitic and stearic, glycerides of certain soluble and volatile fat acids, butyric, capric, caprylic and caproic, which are not present in other animal fats or in vegetable fats. It is desirable, therefore, to determine the amount of the insoluble fat acids contained in a given sample by separating and weighing them. Genuine butter has been found to contain, according to numerous observers, anywhere from 86.00 to 89.80 per cent. while the other animal fats (*e. g.*, mutton and beef fats, and lard) and vegetable fats (*e. g.*, palm oil, sesame oil) contain 95.00 to 95.5 per cent. It is, according to König, rare to find more than 88 per cent. in genuine butter, but 90 per cent. has been suggested as the highest allowable limit.

For the determination of the amount of the insoluble fat acids the method of Hehner is generally conceded to be the best. Three or four grammes of the pure filtered fat are dissolved in 50 c. c. of alcohol, to which is added a gramme or two of solid caustic potash. The mixture is heated until the fat is saponified, then the alcohol is driven off by evaporation, and the syrupy residue dissolved in about 150 c. c. of water. Hydrochloric or sulphuric acid is then added until the reaction is strongly acid and the precipitation of the fat acids is complete. Heat is again applied until the precipitated fat acids are melted to a clear oil. After cooling, the fats are separated by filtration through a weighed filter-paper and thoroughly washed; then the paper, with the insoluble fat acids, is thrown into a weighed beaker, dried and weighed. The percentage is then calculated arithmetically.

Reichert has proposed a method for the determination of the volatile fat acids which gives very accurate results and which is very extensively used. The larger the amount of the volatile acids, the larger the amount of genuine butter present. Two and one-half grammes of pure fat are saponified with 20 c. c of alcoholic potash; 50 c. c. of water are then added, and the soap decomposed by 20 c. c. of dilute sulphuric acid (1:10). The contents of the flask are then distilled cautiously until 50 c. c. have gone over. The distillate is then titrated with decinormal sodic hydrate. Genuine butter requires on an average 14 c. c. of the decinormal sodic hydrate to neutralize the acids yielded by 2.5 grammes of fat. If but 12.5 c. c. or less are required, it is not genuine butter with which one has to deal.

Examination of samples received. — Twenty-one samples of butter varying in price from 22 to 45 cents were received. The examination was confined to the estimation of water, analysis of the fat, and microscopic investigation. The latter was wholly negative in its results. No evidence of adulteration by water was observed; in no case did the amount exceed 15 per cent. In the investigation of the fats, the method of Hehner was employed, and with the results tabulated below.

Number.	DESIGNATION.	Price per Pound.	Per cent. Insol. Fat Acids.	REMARKS.
		Cents.		
1, . . .	Butter, ...	28	89.63	
2, . . .	"	32	90.83	Condemned.
3, . . .	"	38	88.40	
4, . . .	"	34	89.59	
5, . . .	"	30	89.44	
6, . . .	"	25	86.82	
7, . . .	"	22	89.23	
8, . . .	"	23	89.02	
9, . . .	"	35	89.09	
10, . . .	"	33	89.84	
11, . . .	"	30	90.14	Condemned.
12, . . .	"	23	89.12	
13, . . .	"	25	89.43	
14, . . .	Sweet butter, ...	45	88.72	
15, . . .	Prime butter, ...	–	88.65	
16, . . .	Butter, ...	32	88.23	
17, . . .	"	35	87.78	
18, . . .	"	35	95.07	Condemned.
19, . . .	"	35	87 29	
20, . . .	"	40	93.21	Condemned.
21, . . .	"	40	88.33	

Although but four of the above were condemned, it is most probable that several others were more or less adulterated with Oleomargarine.

LARD.

The adulterants of lard are not very numerous, nor does it appear that they are extensively used. The most common adulteration is said to be water, which is not present at all in the pure article. Other substances said to be used are starches, cotton-seed oil, tallow, lime, salt, alum and potassic and sodic carbonates. The addition of salts enables the lard to hold water to a considerable extent.

I received fourteen samples of lard for examination, all of which proved to be free from adulterations. On being melted they with one exception gave off no unpleasant odor, and all were free from water. One sample was somewhat brownish in color and gave off a disagreeable smell when melted. Although there were no evidences of adulteration, I should consider it an unwholesome article.

Spices.

The ground spices are very subject to adulteration to a greater or less degree with almost any cheap substitute which can be presented in powdered form. Some substances which are sold, as pepper, cassia, mustard, etc., do not contain even a trace of the article under whose name they go; others are adulterated to such a slight extent that it would seem to be hardly worth while, from a pecuniary standpoint, to carry on the process of "blending." The substances chosen for adulterating purposes are such as are cheap, capable of being easily powdered, and possessing little distinctive taste or odor; they are almost without exception harmless in their nature. They embrace cheap flours, ship bread, brown bread, rice, beans, pease, flax seed, rape seed, turmeric, Indian meal, "pepper dust," charcoal, sand, terra alba, woody matter, etc., etc. It is said that chromate of lead is sometimes used to give color to mustard compounds, but this practice is probably very rare.

Pepper and Cassia are adulterated with a great many of the above mentioned substances; mustard as very often sold consists in great part of flour and turmeric; cloves are put on the market deprived of their most valuable component, viz., the oil of clove; red pepper is said to be frequently adulterated with very fine brick dust.

In the examination of spices the microscope is of very great assistance.

The following table gives the number of samples received and the results of the examination.

	Whole Number Examined.	Number of Genuine Samples.	Number of Adulterated Samples.	Percentage Adulteration.
Black pepper, ...	64	20	44	68 75
White pepper, ...	44	13	31	70 45
Red pepper, ...	5	5	–	–
Mustard, ...	76	29	47	61.84
Ground clove, ...	11	–	11	100 00
Cassia, ...	2	–	2	100.00
Pimento, ...	2	2	–	–
Ginger, ...	1	1	–	–
	205	70	135	65.878

COFFEE.

Coffee appears in the market under three forms; viz., (1) unroasted, (2) roasted, and (3) roasted and ground. The whole unroasted berries are sometimes improved as far as appearance goes by various coloring matters, some of which are poisonous; but this practice is, I think, not very common. It is alleged by many writers that both the unroasted and roasted berries are cleverly imitated, but there seems to be little evidence to strengthen the allegation. The ground coffee presents a good field for adulteration, and the number of substitutes is quite extensive. Much of the coffee which is sold in packages is very largely adulterated with chiccory, burnt pease and beans, acorns, rye, and caramel. Many of the so-called coffees bearing high-sounding titles (Hygienic Coffee, for instance) contain no coffee whatever; and the "coffee extracts" are as free from anything contained in coffee as they can well be. It does not appear that these latter have any larger sale. The adulterations of coffee are very easily detected. Chiccory, which is the most common adulterant used, is easily recognized by the microscope, and it may be detected by the smell, by yielding a darker and denser infusion, and by the sinking of its particles in water. It also differs from coffee in its chemical characteristics. When present the relative amount may be determined according to various methods which it is unnecessary to describe.

The other adulterations above-mentioned occur quite commonly in package coffees but rarely otherwise. Rye and pease sink in water much more quickly than does coffee. They must be readily recognized by microscopical examination, which is true also of the other adulterants. The infusion of coffee containing roasted cereals, etc., strikes a blue color with iodine.

I received thirty-four samples of coffee for examination, varying in price from 15 to 42 cents per pound. All of them excepting one were pure, and that one contained about 20 per cent. of chiccory.

TEA.

The adulterations of tea include leaves of other kinds, exhausted and faced tea leaves, dirt, sand, iron filings, and catechu. The foreign leaves used for this purpose are beech, sloe, hawthorn, and several others. The coloring matters used for facing are prussian blue, black lead, and indigo.

Good tea should yield an infusion fragrant to the smell and pleasant to the taste. The leaves should not be too much broken up, and there should not be a preponderance of stalk. Genuine tea yields about 6 per cent. of ash; anything above 6 per cent. is suspicious, and more than 8 is certain proof of adulteration. It should possess at least 3 per cent. of soluble ash. The amount and character of the ash are of a certain value in detecting the use of exhausted leaves.

The determination of the extract has but little value as an indication of adulteration, since the amount in genuine teas varies very greatly. The leaves themselves should in all cases be submitted to careful observation. I have examined fifteen samples of teas of different grades and prices. In no case were any foreign leaves detected. The ash was estimated in twelve samples; the results are given below. Of the remaining three specimens two were insufficient in amount for anything more than a careful examination of the leaves, and the ash of the third was through an oversight not estimated.

In none of the samples was there any evidence of "facing."

Number.	Brand.	Price per Pound.	Per cent. Sol. Ash.	Per cent. Insol. Ash.	Per cent. Total Ash.	Remarks.
	Gunpowder, ...	$1 25	3.542	3.108	6.650	No adulteration.
2	Oolong, ...	30	3.170	2.750	5.920	" "
3	Hyson and Oolong, . .	35	3.230	2.310	5.540	" "
4	Oolong and Japan, . .	75	3.665	22 935	26.600	Adulterated.
5	Oolong, ...	40	3.090	2.510	5.600	No adulteration.
6	Oolong, ...	50	3.590	2.210	5 800	" "
7	Oolong, ...	70	3.440	2.148	5.588	" "
8	Japan, ...	60	3.190	3.140	6.330	" "
9	English Breakfast, . .	70	3 930	2 380	6.310	" "
10	English Breakfast, . .	60	3.440	2.800	6.240	" "
11	Japan, ...	50	–	–	–	" "
12	Oolong, ...	–	–	–	–	" "
13	Gunpowder, ...	–	–	–	–	" "
14	English Breakfast, . .	64	3.865	2 555	6.420	" "
15	English Breakfast, . .	–	3.410	2.664	6.074	" "

COCOA AND CHOCOLATE.

Cocoa is the roasted seeds of the Theobroma Cacao. It appears in commerce as cocoa nibs, ground cocoa, and prepared cocoa. The latter form usually contains more or less sugar and starch. Chocolate is a preparation of ground cocoa, sugar, and flavoring. Both chocolate and prepared cocoa, being manufactured articles, possess no standard composition, and hence cannot be considered as adulterated except when found to contain harmful ingredients.

The adulterations of cocoa, so far as known, include sugar, starches of different kinds, brick dust, foreign fats, and peroxide of iron. Examination of suspected samples involves microscopical and chemical analysis. The latter consists in the estimation of the fat (cocoa contains normally from 45 to 49 per cent. fat), of the soluble and insoluble ash, and the amount of phosphoric acid contained in the ash.

I received five samples of cocoa, all of which were unadulterated.

GLUCOSE, HONEY, CONFECTIONERY, SUGAR, AND SYRUPS.

Glucose.—The glucose question is one which has assumed considerable importance within the past few years. Glucose is popularly supposed to be a common and dangerous adulteration of many articles of food and drink, and much has been said and written regarding the supposed dangers attending its use. It is, however, when properly and carefully manufactured, a wholesome food, but rather deficient in sweetening power; when carelessly made it may, as will be shown, rightly be considered a dangerous article to be taken into the system. Glucose is manufactured in immense quantities in this country and is, as far as I can learn, usually prepared with much care. Artificial glucose is produced by the action of heat, diastase, or dilute mineral acids on starch. Commercially, it is, in this country, made from corn, which besides containing a large amount of starch, possesses the additional qualification of being very cheap. The starch is first obtained in a pure condition from the corn, then mixed with water, and the mixture is heated to boiling. Sulphuric acid is added to the extent of about 2 per cent., and it is then boiled about three hours; the starch is by this time converted to sugar and dextrine, both of which are in solution. The free acid is then got rid of by the addition of chalk or marble dust, which, with the acid, forms calcic sulphate, which settles to the bottom, and leaves a clear supernatant fluid which yields glucose and dextrine. Should all of the acid not be removed, or should the calcic sulphate be in any amount retained, it is evident that the product would not be entirely harmless, since disturbances of the digestion might follow its use. Moreover, the contaminations which are ordinarily present in commercial sulphuric acid, will, of course, be present with the acid.

I succeeded in obtaining four specimens of glucose, not, however, without some difficulty, since there exists in the trade a certain reluctance to seem to know anything as to where it may be obtained, and those acknowledging possession decline as a rule to sell except at wholesale. Of the four samples obtained, one was in the form of syrup, one in the form of coarse powder, and two were solid glucose. The syrup contained no free acid or other deleterious matter.

The powder, which, by the way, was sent to a Boston house by a Buffalo firm (now happily defunct) as a sample of glucose for adulterating granulated sugar, contained a very large amount of free sulphuric acid, and, moreover, a large trace of arsenic which existed probably as a contamination of the acid used in its manufacture. The two samples of solid glucose were perfectly pure and wholesome.

Honey. — The adulterations of honey are glucose and other syrups, gypsum, starch, etc., etc. Much of the honey of commerce consists almost entirely of glucose, the presence of which will be revealed by polarization. The addition of cane-sugar is detected by the same means, the observations being made before and after inversion. It is alleged that the honey sold in the combs is frequently nothing more than glucose, in artificial comb made of paraffine. This fraud can be easily detected. The presence of gypsum, starch, etc., can be detected by the ordinary methods. Genuine honey always contains more or less pollen which can be easily distinguished by means of the microscope.

I received three samples of honey, two of which were chiefly glucose. I received also one sample of beeswax which was found to contain considerable paraffine.

Confectionery. — Since there is no standard composition possible with regard to candies, it would be difficult to include anything except deleterious substances under the head of adulterations. The poisonous colors are not now, so far as I can learn, commonly found in candies. The use of arsenical papers as wrappers is a practise more or less in vogue, and this should be discouraged. In the manufacture of cheap candies considerable glucose, starch and terra alba are used.

I examined four samples of cheap confectionery all of which contained considerable starch and glucose; no terra alba or harmful coloring matter was present in any case.

Sugar and Syrups. — The lists of substances which have been used for adulterating sugars and syrups is very long and varied; it includes glucose, flour, sand, chalk, terra alba, marble dust, and many other organic and inorganic substitutes of a cheap nature. It is highly improbable that many of the list are used to any great extent, if at all. Glucose is the adulterant most frequently used. Many sugars contain a considerable amount of dirt and other accidental impurities, and unless these are present in very large proportions they cannot be considered as adulterations. The sugar mite is sometimes met with in very low grade sugars, but it is by no means common.

The sugars in common domestic use are loaf, granulated, powdered, yellow, and brown. Loaf sugar is almost invariably pure. Granulated sugar is sometimes adulterated with powdered glucose. The powdered white sugar is said to be sometimes adulterated with flour, terra alba and chalk. The white sugars are frequently given a bluish tint by ultramarine, indigo, and prussian blue. The yellow and brown sugars, especially the cheaper grades, are the most commonly adulterated; they may, however, contain normally as much as fifteen per cent. of glucose. Iron is sometimes an accidental contamination of the latter class of sugars; its presence is revealed by the black discoloration which occurs when a sugar containing it is used with tea. Syrups and molasses are quite commonly adulterated with glucose and water. Maple syrup is sometimes adulterated with other syrups and with water.

The detection of the starches and of the inorganic adulterants presents no difficulty. The coloring matters above-mentioned are also detected with ease. The detection and estimation of glucose is the point which demands more attention than anything else connected with the examination of sugars. In this work the polariscope plays a most important part; the methods of using this instrument is hardly necessary to describe. In addition to the optical process there are two very good methods for the detection of glucose in mixed sugars; viz., those of Casamajor and Boettger. Casamajor's is the better of the two; he treats a dried portion of the suspected sample with methyl alcohol saturated with glucose. This dissolves out all cane and invert sugar but leaves the starch sugar undissolved. Boettger mixes a solution of the sugar with an equal volume of a solution of carbonate of sodium, then adds some basic nitrate of bismuth, and heats to boiling; if glucose be present the solution becomes blackened. On account of the blackening, which may be due to albumen, Brucke proposes the use of potassium bismuth nitrate which precipitates any albumen which may be present.

I received twelve samples of sugar and eighteen of syrup for examination. Of the twelve sugars five were powdered, six were granulated and the twelfth was a yellow "coffee sugar." The five powdered sugars were free from adulterations; of the six granulated samples five were pure and one contained powdered glucose. The yellow sugar contained but 2.80 per cent. of invert sugar. The syrups were, with two exceptions, passed as genuine; one consisted entirely of glucose; the other, a maple syrup, was very largely adulterated with cane sugar.

OLIVE OIL.

A great proportion of what is sold as olive oil appears to consist wholly or in part of the cheaper oils, notably the oil of cotton seed. This latter is refined in great quantities in this country, and there are several establishments where it is bottled, furnished with a label representing it to be "Huile d'Olive Vierge, surfine clarifiée," etc., etc., and sent out with all the appearance of the imported article. The processes which have been proposed for detection of adulterations of olive oil are very numerous and unsatisfactory; they may be divided into physical and chemical. The physical examination embraces the observation of specific gravity, spectrum, "cohesion figures," and solidifying point. The chemical embraces the elaidin test, the nitric acid, and several other tests. The simplest of all these, and one which is of as much service as any, is the nitric acid test, which will detect the addition of cotton or other seed oils when present to the extent of five per cent. or more.

I received 49 samples of "olive oil" the brands, prices (reckoned for the half pint), and genuineness of which are tabulated below.

Number.	DESCRIPTION.	Price (per half pint.) [Reckoned.]	REMARKS.
		Cents.	
1	Finest Sublime Lucca Oil. S. Rae & Co., Leghorn, ...	61	Genuine.
2	Huile d'Olive Vierge. Surfine extra. Ne Plus Ultra. Vve. Chaffard, Jardin de la France,	45	Genuine.
3	Huile d'Olive. Superfine Clarifiée. Bastou & Guestier, Bordeaux, ...	45	Genuine.
4	Huile d'Olive Clarifiée. Qualite extra. Victor Panet, Bordeaux, ...	45	Genuine.
5	Virgin Oil of Aix. Choicest Salad Oil, . .	42	Genuine.
6	Huile d'Olive Vierge. E. Loubon, Nice, . .	15	Spurious.
7	Huile d'Olive Surfine Clarifiée. R. L. Dacosini, Nice, ...	30	Numbers 7, 8, 9 and 10 bore the same inscription, but the labels were not alike, nor were the oils all of the same color; two were rather pale yellow, and two deep yellow. All were spurious.
8	Same label as No. 7, ...	20	
9	Same label, ...	30	
10	Same label, ...	40	
11	Sublime Lucca Oil. S. Rae & Co., . . .	55	Genuine.
12	Huile d'Olive Vierge. Lepine Fils, Bordeaux,	17	Spurious.
13	Huile d'Olive Vierge. E. Louwron, Nice, .	30	Spurious.
14	Huile d'Olive Vierge. E. Loubon, Nice, . .	20	Spurious.
15	Huile d'Olive Vierge d'Aix. De Possel Fils, Marseille, ...	42	Genuine.
16	Finest Lucca Oil, ...	35	Genuine.
17	Huile d'Olive Vierge. E. Loubon, Nice, . .	30	Numbers 14, 17, 18, 19, 20, 21 and 22 bore labels with the same inscription, but printed in different shades of red, blue and brown. The oils varied in color from pale yellow to orange. They were all spurious.
18	Same label as No. 17, ...	20	
19	Same label, ...	20	
20	Same label, ...	20	
21	Same label, ...	40	
22	Same label, ...	20	
23	Huile d'Olive Vierge. S. Larcher Jeune, Bordeaux, ...	35	Genuine.
24	Finest Sublime Lucca Oil. S. Rae & Co., Leghorn, ...	65	Genuine.
25	Huile d'Olive Vierge. E. Loubon, Nice, . .	20	Spurious (see 17.)
26	Huile d'Olive Vierge. Videau & Brun, Bordeaux, ...	70	Genuine.
27	Finest Sublime Lucca Oil. S. Rae & Co., Leghorn, ...	55	Genuine.
28	Superfine Huile d'Olive. Nice, ...	62	Spurious.
29	Huile d'Olive Surfine. R. L. Dacosini, Nice, .	30	Spurious.
30	Huile d'Olive. Superfine Clarifiée. Adolphe Puget, Nice, ...	40	Spurious.
31	Finest Sublime Lucca. Leutini & Co., Santa Chiara, ...	37	Spurious.

Number.	DESCRIPTION.	Price (per half pint.) [Reckoned.]	REMARKS.
32	Finest Sublime Lucca. Leutini & Co., Santa Chiara, ...	30	Genuine.
33	Huile d'Olive Vierge. D 126. E. Loubon, Nice,	20	Spurious.
34	Same label, ...	30	Spurious.
35	Huile d'Olive Vierge, F. A. O. E. Loubon, Nice, ...	30	Spurious.
36	Huile d'Olive Vierge. D 126. E. Loubon, Nice,	20	Spurious.
37	Finest Sublime Lucca Oil. S. Rae & Co., Leghorn, ...	65	Genuine.
38	Vve. Garres Jne. & Fils. Usine St. Nicolas, Bordeaux, ...	35	Genuine.
39	Huile d'Olive Vierge. U 126. E. Loubon, Nice,	20	Spurious.
40	Houile d'Olive Vierge. E. Loubon, Nice, .	20	Spurious.
41	Pure Sweet Oil, put up by Kellogg Manufacturing Co., Boston, ...	40	Spurious.
42	Huile d'Olive. Bastou & Guestier, Bordeaux,	40	Genuine.
43	Huile d'Olive Surfine Clarifiée. R. L. Dacosini, Nice, ...	34	Spurious.
44	Huile d'Olive Vierge, F. A. O. E. Loubon, Nice, ...	20	Spurious.
45	No label, ...	20	Spurious.
46	Huile d'Olive Vierge. E. Loubon, Nice, . .	20	Spurious.
47	Same label, ...	20	Spurious.
48	Same label, ...	20	Spurious.
49	No label, ...	-	Genuine.

It will be remarked from the above table that the price is, as with other articles of food, no criterion of the real value. In the case of the two samples numbered 31 and 32, bearing exactly the same labels, the spurious one was the more expensive. Number 31 showed no brand on the cork, and herein lay the only difference in outward appearance between the two. The samples marked spurious were beyond doubt nothing more than cottonseed oil.

VINEGAR.

The adulterations of vinegar are water, mineral acids, common salt, capsicum, burnt sugar, and others of lesser importance. The addition of sulphuric acid to the extent of one-thousandth part by weight is permitted in Great Britain.

Good vinegar should contain at least three per cent. of acetic acid; if it contain less it is without doubt diluted with water. The standard for cider vinegar is somewhat higher, but as all the samples purchased were delivered as "Vinegar" the standard of the Society of Public Analysts has been taken in their examination.

The specific gravity of the best vinegar reaches as high as 1.022; if below 1.015 the sample contains more or less added water.

Nitrate of silver and chloride of barium should, on addition to a good vinegar produce no more than a slight cloudiness.

I received seventeen samples of vinegar, which were examined and gave the following results.

Examination of Vinegars.

Number.	Price per Pint.	Per cent. Acetic Acid.*	REMARKS.
	Cents.		
1, ...	5	4.125	
2, ...	4	2.82	Condemned.
3, ...	5	3.57	
4, ...	4	4.92	
5, ...	5	2.70	Condemned.
6, ...	5	4 50	
7, ...	4	3.96	
8, ...	4	4.05	
9, ...	5	4.05	
10, ...	4	3.72	
11, ...	4	4.83	
12, ...	4	3 96	
13, ...	4	3.33	
14, ...	4	3.30	Contained much salt. Condemned.
15, ...	3	3.03	
16, ...	4	4.86	
17, ...	4	5.19	

* In no case was any mineral acid detected.

Many of the above were undoubtedly more or less watered, and would, but for the fact that they were sold simply as vinegar, and not as cider vinegar, have been condemned.

The collectors have been notified to ask in future for cider vinegar, a standard strength for which will probably be soon established.

PICKLES.

Pickles are said to frequently contain copper and alum, which are employed to impart a bright green color. Of seven samples examined none contained either of these substances. One sample was unfit to be eaten, the pickles being soft, slimy, and friable.

LIME JUICE.

Lime juice of good quality is a clear pale yellow fluid of about 1.037 sp. gr. According to the English Board of Trade standard it should possess at least six per cent. of acidity reckoned as citric acid, but two samples of the juice used in the royal navy and examined by Parkes contained respectively 4.61 and 5.36 per cent. In commerce it is sometimes mixed with spirit, and frequently with water. The adulterations used are tartaric, sulphuric, hydrochloric, and nitric acids, all of which are easily detected by their appropriate tests. I examined five brands of this product, none of which contained any foreign acids. The acidity reckoned as citric acid was with one exception over 6 per cent.; the five samples possessed, respectively, 5.69, 6.016, 6.23, 6.336, 6.688 per cent.

BREAD, FLOUR AND OTHER FARINACEOUS FOODS.

Bread. — Good wheaten bread should be white, or only slightly brownish in color, not tough in consistence, nor acid in reaction; it should be "light" throughout, should not be too moist nor too dry; and the crust should be well baked. There has as yet been no absolute limit set on the amount of water which bread may contain. According to Wanklyn, however, a good bread should contain not more than 34 per cent. of water. The adulterations said to be met with in bread include other flours (pea, bean, rice, etc.), potatoes, borax, alum, sulphate of copper and others. It is very improbable that substitutes for wheat flour are used to any extent in this country as an admixture in the making of wheaten bread. Alum and copper are no doubt sometimes added, intentionally and otherwise. Many of the baking powders contain alum as an adulteration, and in this way it may be and probably is innocently added to the dough. It has been virtually decided that alum exerts a very pernicious influence on the digestion, and hence it falls under the head of deleterious adulterations.

The examination of bread should include the determination of the amount of water, and testing for alum and copper. The percentage of water is determined by expelling the water from a weighed amount of the crumb, re-weighing, and calculating the amount from the difference in weight. Copper may be tested for in the usual manner. In testing for alum various methods are in vogue; they include the so-called "Logwood test," with its several modifications, and a number of processes for the quantitative estimation of alumina.

I received ten samples of bread for examination; in no case was alum or copper present. Their percentage of water is shown by the table below.

Number.	Percentage Water.	Number.	Percentage Water.
1, ...	44.00	6, ...	39.80
2, ...	40.26	7, ...	39.16
3, ...	43.00	8, ...	40.75
4, ...	40.98	9, ...	42.60
5, ...	37.90	10, ...	34.66

It will be remarked that all of these specimens contained more water than, in the opinion of Mr. Wanklyn, should be allowed.

Wheaten Flour. — When of good quality, this very important article of food should be perfectly white, or at most with a very slight tinge of yellowish, perfectly free from bran, with no unpleasant odor, and quite free from acidity. It should also possess a certain degree of cohesiveness, and should not contain more than fifteen per cent. of water.

It does not appear that flour is subject to extensive adulteration in this country, though in Europe it is, especially in times of want, quite commonly adulterated. It is subject both to accidental contamination and fraudulent adulteration. Under the first head come mildew, darnel and ergot. Under the second, the following have been mentioned: — damaged and inferior flours, the flours of other cereals, alum, chalk and other mineral impurities. One instance is recorded in Germany of adulteration with salts of barium whereby poisonous symptoms were produced, which in one case brought about a fatal result. This was, however, probably accidental.

In the examination of flour and of other starchy foods the microscope is an invaluable and very necessary aid. Chemically the starches are identical; microscopically they vary greatly, and to the practised eye the detection of fraudulent admixture is, in most cases, by means of this instrument a not difficult matter.

I received seventeen samples of flour, which on examination were found to be of good quality, and quite free from adulteration. The price per pound varied from four to six cents.

Other farinaceous Foods. — The examination of the foods which come under this head varies not materially from that of wheat flour; the adulterations of some are chiefly cheaper starches, while others, so far as is known, are never tampered with. As has been already mentioned, the microscope is in this work a necessary assistance. Of the articles enumerated below all were found to be genuine.

DESIGNATION.	No. of Samples.	DESIGNATION.	No. of Samples.
Corn Starch, ...	4	Barley, ...	3
Corn Meal, ...	2	Oatmeal, ...	5
Rye Flour, ...	1	Sago, ...	6
Rye Meal, ...	2	Tapioca, ...	6

BAKING POWDERS AND CREAM OF TARTAR.

The compounds known as baking powders consist chiefly of bicarbonate of sodium with an acid salt, usually bitartrate of potassium. Some, however, contain tartaric acid, or acid phosphate of calcium, and others alum. In order to prevent the decomposition and deterioration so likely to occur from contact of an acid salt with bicarbonate of sodium, a certain amount of rice flour is usually added to the mixture.

Since each manufacturer has his own formula for preparing his brand of the compound, it would, of course, be a difficult matter to decide what should be considered as adulteration. It would, perhaps, be proper to consider the alum powders as adulterated, since alum is very generally held to exert a more or less pernicious effect upon the system. Of twelve baking powders examined, none contained any alum or other deleterious ingredient.

Cream of Tartar. — This substance, which is much used in cookery, is the bitartrate of potassium; it contains usually a certain amount of tartrate of calcium as an impurity, averaging about six or seven per cent. The U. S. Pharmacopœia (1880) allows the presence of six per cent. of this impurity. On account of its high price it is subject to very great adulteration. The substances in common use as adulterants are alum, starch, tartaric acid, terra alba, chalk, acid phosphate of calcium and tartrate of calcium.

In the examination of the 67 samples received, all those containing 90 per cent. of bitartrate of potassium were passed as genuine. Of the entire number (67) forty-seven were found to be good specimens and twenty adulterated. In these latter all of the above-mentioned adulterations were found; most of the twenty were doubly adulterated, containing, besides starch, one or another of the above list of fraudulent adulterations.

MISCELLANEOUS.

I received in addition to the above enumerated samples two bottles of wine, both of which were watered and plastered, and five boxes of sardines, of which four were acknowledged to be young herrings in cotton-seed oil.

REPORTS OF THE ANALYSTS OF MILK.

REPORTS OF THE ANALYSTS OF MILK.

BOSTON, March 31, 1884.

Dr. S. W. ABBOTT,
Health Officer, State House.

DEAR SIR: — I have the honor to present the following report on the examination of milk.

Very respectfully,

CHARLES HARRINGTON, M. D.

DR. HARRINGTON'S REPORT.

Since my appointment, in October last, as milk analyst for Eastern Massachusetts, I have received and examined 241 samples of milk, which were obtained from most of the cities and large towns east of Worcester. The greater part were purchased at random from the retail shops; nineteen of the whole number were obtained from contractors and milk-wagons. If we may take these hap-hazard samples as a fair indication of the character of the whole milk supply of the various places from which they were obtained, it will be remarked on comparing the results of the examinations, that certain cities enjoy a very much better supply than others, and that the milk of Boston stands among the lowest in the scale. The examination of samples was confined in most cases to the estimation of the percentage of total solids, fat, and water, and observation of specific gravity.

The results obtained show that but a small percentage of samples are up to the statute standard (13 per cent. total solids,) and that but few more reach the average of good milk, (about 12.50 per cent. total solids).

Boston (City proper). Sixty-eight samples were received; forty-nine of these were purchased at retail shops; nineteen were obtained from contractors and milk-wagons.

A. *Retail shops*. 49 samples.

Average per cent. total solids,	10.84
Highest,	14.12
Lowest,	8.10
Water,	89.16
Highest,	91.90
Lowest,	85.88
Fat,	2.62
Highest,	4.00
Lowest,	1.65
Above standard,	2
Below standard,	47
Above, 12.5 per cent. total solids,	4
Above 12.0 per cent. total solids,	6
Percentage of samples adulterated (13 per cent. standard),	95.92

B. *Contractors and Milk-wagons*. 19 samples.

Average per cent. total solids,	12.79
Highest,	18.82
Lowest,	10.44
Water,	87.21
Highest,	89.56
Lowest,	81.18
Fat,	3.41
Highest,	9.82
Lowest,	2.05
Above standard,	7
Below standard,	12
Above 12.5 per cent.,	9
Above 12.0 per cent.,	14
Percentage of samples adulterated,	63.16
Percentage of samples adulterated, Class A,	95.92
Percentage of samples adulterated, Class B,	63.16
Percentage of samples adulterated, Class A and B,	86.78

The best specimen of the whole number represented the last third of a milking — "strippings" — and was obtained from a producer who has his own milk route. A complete analysis of this sample gave the following figures : —

Fat,	9.82
Milk sugar,	4.00
Albuminoids,	4.21
Ash,	0.79
Total solids,	18.82
Water,	81.18

East Boston. 10 samples.

Average per cent. total solids,	11.49
Highest,	14.15
Lowest,	9.20
Water,	88.51
Highest,	90.80
Lowest,	85.85
Fat,	2.58
Highest,	3.80
Lowest,	1.90

Above standard,	2	Above 11.5 per cent.,	3
Below standard,	8		
Percentage adulterated,			80.00

South Boston. 16 samples.

Average per cent. total solids,	10.39
Highest,	13 18
Lowest,	7.69
Water,	89.61
Highest,	92.31
Lowest,	86.82
Fat,	2.54
Highest,	4.12
Lowest,	1.38

Above standard,	1	Above 12 per cent.,	2
Below standard,	15	Above 11 per cent.,	4
Percentage adulterated,			93.75

Charlestown District. 14 samples.

Average per cent. total solids,	10.34
Highest,	13.80
Lowest,	8.00

Water,	89.66
Highest,	92.00
Lowest,	86.20
Fat,	2.35
Highest,	4.30
Lowest,	1.50

Above standard,	1	Above 12 per cent.,	2
Below standard,	13	Above 11 per cent.,	3
Percentage adulterated,			92.86

Cambridge. 18 samples.

Average per cent. total solids,	11.71
Highest,	14.90
Lowest,	10.00
Water,	88.29
Highest,	90.00
Lowest,	85.10
Fat,	2.59
Highest,	3.55
Lowest,	1.60

Above standard,	3	Above 12 per cent.,	5
Below standard,	15		
Percentage adulterated,			83.33

Somerville. 6 samples.

Average per cent. total solids,	.62
Highest.	11.90
Lowest,	9.85
Water,	89.38
Highest,	90.15
Lowest,	88.10
Fat,	2.36
Highest,	3.10
Lowest,	1.70

Above standard,	0	Above 12 per cent,	0
Below standard,	6	Above 11 per cent.,	2
Percentage adulterated,			100

Newton. 8 samples.

Average per cent. total solids,	12.19
Highest,	13.47
Lowest,	10.38

Water,	87.81
Highest,	89.62
Lowest,	86.53
Fat,	2.94
Highest,	3.90
Lowest,	1.80

Above standard,	3	Above 12 per cent.,	4
Below standard,	5		
Percentage adulterated,			62.50

Chelsea. 10 samples.

Average per cent. total solids,		11.33
	Highest,	15.40
	Lowest,	6 10
	Water,	88.67
	Highest,	93.90
	Lowest,	84.60

Above standard,	2	Above 12 per cent.,	5
Below standard,	8		
Percentage adulterated,			80

Lynn. 10 samples.

Average per cent. total solids,		11.79
	Highest,	16.20
	Lowest,	9.00
	Water,	88.21
	Highest,	91.00
	Lowest.	83.80

Above standard,	2	Above 12.5 per cent.,	3
Below standard,	8	Above 11.5 per cent.,	5
Percentage adulterated,			80.00

Salem. 10 samples.

Average per cent. total solids,		11.61
	Highest,	13.55
	Lowest,	10.45
	Water,	88.39
	Highest,	89.55
	Lowest,	86.45
	Fat,	2.69
	Highest,	3.60
	Lowest,	1.95

Above standard,	1	Above 12 per cent.,	3
Below standard,	9	Above 11.5 per cent.,	5
Percentage adulterated,			90.00

Lowell. 10 samples.

Average per cent. total solids,	11.50
Highest,	14.90
Lowest,	9.70
Water,	88 50
Highest,	90.30
Lowest,	85.10
Fat,	2.97
Highest,	3.90
Lowest,	2.00

Above standard,	1	Above 12.5 per cent..	2
Below standard,	9	Above 12 per cent.,	3
Percentage adulterated.			90.00

Haverhill. 10 samples.

Average per cent. total solids,	12.89
Highest,	14 95
Lowest,	11.10
Water,	87.11
Highest,	88.90
Lowest,	85.05
Fat,	2 96
Highest,	4.35
Lowest,	1 60

Above standard,	4	Above 12.5 per cent ,	6
Below standard,	6	Above 12.0 per cent.,	8
Percentage adulterated,			60.00

Lawrence. 10 samples.

Average per cent. total solids,	13.43
Highest,	15.60
Lowest,	10.40
Water,	86.57
Highest,	89.60
Lowest,	84.40

Above standard,	8		
Below standard,	2		
Percentage adulterated,			20.00

Worcester. 12 samples.

Average per cent. total solids,	13.41		
Highest,	16.00		
Lowest,	11.40		
Water,	86.59		
Highest,	88.60		
Lowest,	84.00		
Fat,	3.88		
Highest,	5.25		
Lowest,	3.00		
Above standard,	6	Above 12.5 per cent.,	7
Below standard,	6	Above 12.0 per cent.,	11
Percentage adulterated,	50.00		

New Bedford. 10 samples.

Average per cent. total solids,	13.63		
Highest,	15.25		
Lowest,	11.40		
Water,	86.37		
Highest,	88.60		
Lowest,	84.75		
Fat,	3.42		
Highest,	4.90		
Lowest,	1.80		
Above standard,	6	Above 12.5 per cent.,	8
Below standard,	4		
Percentage adulterated,	40.00		

Fall River. 10 samples.

Average per cent. total solids,	12.12		
Highest,	13.60		
Lowest,	10 65		
Water,	87.88		
Highest,	89.35		
Lowest,	86.40		
Fat,	2.73		
Highest,	3.40		
Lowest,	2.35		
Above standard,	3	Above 12 per cent.,	4
Below standard,	7		
Percentage adulterated,	70.00		

Other Towns. 9 samples.

Average per cent. total solids,	13.16
Highest,	15.90
Lowest,	11.76
Water,	86.84
Highest,	88.24
Lowest,	84.10

Above standard,	3	Above 12.5 per cent.,	4
Below standard,	6	Above 12 per cent.,	7
Percentage adulterated,			66.67

Recapitulation.

LOCALITY.	Number of samples examined.	Number above 13 per cent. standard.	Number below standard.	Number above 12.5 per cent. T. S.	Percentage of adulteration, reckoning all below 13 per cent. T. S. adulterated.	Percentage of adulteration, reckoning from average of good milk (12.50 per cent. T. S.)
Boston, Class A,	49	2	47	4	95.92	91.84
Boston, Class B,	19	7	12	9	63 16	52.63
Boston, Classes A and B,	68	9	59	13	86.78	80.89
East Boston,	10	2	8	2	80.	80.
South Boston,	16	1	15	1	93.75	93.75
Charlestown District,	14	1	13	2	92 86	86.14
Cambridge,	18	3	15	3	83.33	83.33
Newton,	8	3	5	4	62.50	50.
Somerville,	6	–	6	–	100.	100.
Lynn,	10	2	8	3	80.	70.
Chelsea,	10	2	8	2	80.	80.
Lowell,	10	1	9	2	90.	80.
Salem,	10	1	9	1	90.	90.
Lawrence,	10	8	2	8	20.	20.
Haverhill,	10	4	6	6	60.	40.
New Bedford,	10	6	4	8	40.	20.
Fall River,	10	3	7	3	70.	70.
Worcester,	12	6	6	7	50.	41.67
Other towns,	9	3	6	4	66.67	55.55
Totals,	241	55	186	69	77.45	71.37

The principal modes of adulteration are the abstraction of the cream, and "lengthening" with water; both methods are sometimes practised on the same milk. This double adulteration makes the so-called lactometer test of but little value in the inspection of milk as it is usually carried on, for the reason that the addition of a certain amount of water to a skimmed milk brings the specific gravity back to that of normal "whole" milk. The use of the lactometer is, however, oftentimes of considerable assistance, especially in the drawing of inferences. The lactodensimeter has been used for the observation of the specific gravity in the examination of all of the samples reported above.

For the estimation of the fat three methods have been employed; the gravimetric, the Soxhlet areometric, and the Feser method. The latter gives approximately accurate results and is, in many cases, of considerable convenience.

Respectfully submitted.

CHARLES HARRINGTON, M. D.

Western Massachusetts.

The following report embraces the results of analyses made by Prof. Charles A. Goessmann of Amherst, of samples of milk obtained in nine cities and towns of Western Massachusetts, from October 1, 1883, to March 31, 1884.

They show that the adulteration of milk in the four Western counties of the State is by no means so common as in the larger cities and towns of the Eastern portion.

The whole number of samples obtained was seventy-nine. Thirteen were obtained from milk-wagons, and sixty-six from retail shops.

The average of the whole was 12.92 total solids. The lowest, 10.35.

Two only of the whole number fell below 11 per cent. The seventy-nine samples were taken as follows: —

Springfield,	19 samples.	Average, . . .	12.67
		Lowest, . . .	10.35

Holyoke,	17 samples.	Average, . . .	12.53
		Lowest. . . .	11.06
Pittsfield,	12 samples.	Average, . . .	12.68
		Lowest, . . .	11.45
North Adams,	6 samples.	Average, . . .	12.73
		Lowest, . . .	12.15
Northampton,	6 samples.	Average, . . .	14.36
		Lowest, . . .	12.07

The high average of these six samples is produced by one unusually rich sample, which was undoubtedly taken from a can of cream, and showed 23.23 on analysis. The average of the remaining five samples was 12.59.

Greenfield,	6 samples.	Average, . . .	12.80
		Lowest, . . .	11.91
Amherst,	5 samples.	Average, . . .	13.71
		Lowest, . . .	12.67
Agawam,	5 samples.	Average, . . .	13.39
		Lowest, . . .	12.54
South Hadley,	3 samples.	Average, . . .	13.39
		Lowest, . . .	12.55

REPORT OF THE ANALYST OF DRUGS.

PROF. BENNETT F. DAVENPORT, M. D.

REPORT OF THE ANALYST OF DRUGS.

DR. BENNETT F. DAVENPORT.

To S. W. ABBOTT, M. D., *Health Officer of the Massachusetts State Board of Health, Lunacy and Charity.*

SIR: — I have the honor to make the following report upon my first year's work as analyst to the Board, during which time I have examined 680 samples of United States Pharmacopœial drugs, and have found 284 of them, that is, 41.67 per cent., to be adulterated within the meaning of the act under which I am appointed. This act defining as an adulteration in drugs (which include all medicines for internal or external use, antiseptics, disinfectants, and cosmetics): (1) if, when sold under a name recognized in the United States Pharmacopœia, it differs from the standard of strength, quality or purity laid down therein; (2) if, when sold under or by a name not recognized in the United States Pharmacopœia, but which is found in some other pharmacopœia, or other standard work on materia medica, it differs materially from the standards of strength, quality or purity laid down in such work; (3) if its strength or purity falls below the professed standard under which it is sold.

In the collection of drugs for examination, those principally have been chosen which are in themselves of most importance, medicinally, or have been reported as wanting in strength, quality or purity in some of the more recently published pharmaceutical works, journals or reports of analysts. In the making of the collections, almost all the cities and larger towns throughout the State have been canvassed, it having been one of the principal objects of the first year's work to ascertain the actual condition, as regards adulteration, as defined by the statute, of the drugs sold to the consumers throughout the entire State. During the earlier part of the year while this was still the prime object of the collections, the names of those from whom the samples were obtained were not recorded when they were examined, as was done at a later date.

The drugs of the United States Pharmacopœia have been the ones most largely examined, as for these there was an undoubted standard provided. The methods of examination followed have been those given in the United States Pharmacopœia itself, supplemented in their execution by such recognized commentaries thereon as the United States and the National Dispensatory, and also by the recent revision of the German Pharmacopœia and its leading commentaries.

The following are the detailed results of my examinations of the several drugs, beginning with those which are of the most importance.

In the case of Powdered Opium, the U. S. P. revision of 1880, which the court has decided to be the one mentioned in the statute, the requirements are that "for pharmacopœial or medical uses powdered opium should contain not less than 12 nor more than 16 per cent. of morphine, when assayed by the process given under the title *Opium*." This making of the process itself part of the requirement, instead of simply requiring that it should contain any certain absolute percentage, is a very great advantage for the obtaining of a uniform strength. As every different method of assay would be likely to give a different percentage, and none yet known is conceded to give the exact per cent. of the amount contained, there would without a specific method be no definiteness in the requirement. As about 14 per cent. of morphine has been found to be the average strength of the pure powdered opium used for pharmaceutical purposes in this country, the limited variation of only two per cent. on either side thereof will not admit of any dangerous variation in the strength of medicines to be prepared therefrom; yet will allow the use of all samples of good opium likely to be found in our market under the proper enforcement of the revenue custom standard as established since 1848, which admits into this country no opium which in its normal moist condition does not contain at the least 9 per cent. of morphine.

The 46 samples of Powdered Opium which I have assayed have yielded respectively as follows: —

			Per cent.
1.	Boston,	Sold as Powers & Weightman's,	13.00
2.	"	" " "	11.68
3.	"	" " "	14.10
4.	"	" " "	16.42
5.	"	" " "	15.96
6.	"	" Lauman & Kemp's,	14.42
7.	"	His own powdering,	14 42
8.		Squibb's,	15.00
9.	"	Squibb's,	14.40
10.	Newton,		13.54
11.	Cambridge,	B. O. Wilson's,	15.06
12.	Roxbury,	Powers & Weightman's,	12.00
13.	Somerville,		9.20
14.	Roxbury,		12.00
15.	Winchester,		12.10
16.	Roxbury,	Powers & Weightman's,	12.50
17.	Somerville,		14.00
18.	Boston,		13.00
19.	Fitchburg,		15.08
20.	"		12.92
21.	Boston,		10.70
22.	"		13.72
23.	"	Squibb's,	13.20
24.	"	"	15.20
25.	"	Powers & Weightman's,	11.60
26.	"	Weeks & Potter,	13.50
27.	"		13.00
28.	Lowell,	Powers & Weightman's,	11.30
29.	Boston,	Rosengarten & Sons,	12.54
30.	"	Squibb's,	13.34
31.	"	"	14.00
32.	"	Powers & Weightman's,	12.44
33.	"	" "	14.00
34.	"	Squibb's,	15.40
35.	"	"	13.28
36.	Stoneham,	"	14.00
37.	Rockland,		12.04
38.	Boston,	Squibb's,	13.74
39.	"	"	13.30
40.	"		12.64
41.	Hingham,		12.80
42.	"	Powers & Weightman's,	13.24
43.	Boston,	" "	15.20
44.	Brighton,	" "	13.48
45.	Roxbury,	" "	11.10
46.	Leominster,		14.30

Thus of these 46 samples one only (the 4th) exceeded the allowable maximum of 16 per cent., while only 6 samples or 13.05 per cent. fell below the minimum limit of 12 per cent., although several of them appeared to have been reduced by sugar of milk.

The difference in the required "not less than 10 per cent." of the U. S. P., 1870, and the 12 per cent. of the U. S. P., 1880, is really less than has been thought, for the reason that the purification by filtration through animal charcoal as required by the U. S. P., 1870, will account for the most, if not the whole, of the apparent difference of 2 per cent. between the two standards, so that the standard has really been raised hardly any, if any at all.

In Tincture of Opium, or Laudanum, the U. S. P., 1880, now requires 10 parts of powdered opium to be exhausted in the making up of 100 parts of the tincture, while formerly the U. S. P., 1870, required but about 9 parts. Thus it was practically but about one-tenth weaker than at present, for the same grade of powdered opium was used then as now, it not being the custom of many pharmacists then, or now even in the largest cities, to assay their powder or tincture, and dilute it down to the minimum strength allowed. The present prescribed process of percolation is, however, more likely to secure a thorough exhaustion of the powder than the former process of maceration, and will practically always do so if the full directions given under percolation in the preliminary notices of the pharmacopœia are carefully followed. I have myself made samples of tinctures of opium both according to the U. S. P., 1870, and of that of 1880, both uncorrected and corrected, and I have also had them made under my own supervision by competent pharmacists of this city, who had formerly been students under me at the Massachusetts College of Pharmacy. Of each of these tinctures I have made at the least three assays, as I had of the powders from which they were made. Those correctly made according to the U. S. P., 1880, have all assayed out to within at most a very few one hundredths of 1 per cent. of exactly one tenth part of the percentage of the powder itself from which they were made, the variation being sometimes above as well as below the opium percentage, but always falling well within the limits of the experimental error.

In the process of assay for the Tincture, that directly prescribed for "Opium in any condition to be valued" has been followed, as being the one indirectly required. Seventy grammes of the tincture is therefore taken, as it is made from one-tenth part powdered opium, and it is dried at a temperature not exceeding 85°C, just the same as is required for powdered opium. The dried residue thus obtained, is then proceeded with exactly as is directed under opium assay. But the amount of dried crystals obtained is to be multiplied by two, in order to determine the percentage of morphine contained in the tincture, as yielded by this process. This percentage of morphine by weight, and the specific gravity of the tincture itself being taken, allows of comparisons being made with other methods of expressing the strength of the preparation, such as grains of morphine per fluid ounce, which method, however, is much less definite. Many of our most reliable pharmacists are now making up their laudanum as if from opium of the average pharmacopœial, that is, of 14 per cent. morphine, strength, using more or less than the prescribed 10 parts of the opium according as its assay percentage falls below or above this average of 14 per cent. A tincture is thus obtained that will yield 1.40 per cent., or about 6 grains of morphine per fluid ounce upon assay.

The following results have been obtained from the assay of 100 samples of the Tincture of Opium obtained throughout the State Of these the average morphine strength was 0.965 per cent., or of about 80 per cent. of the U. S. P., 1880, minimum. Four samples, or 4 per cent., exceeded the maximum limit of 1.60 per cent. of morphine, while 82 samples, or 82 per cent., fell below the minimum of 1.20 per cent. of morphine; 45 samples, however, or 45 per cent., contained about 1 per cent. morphine, which was required by the U. S. P., 1870, if assayed by the modern process of the U. S. P., 1880. The specific gravities at 15°C. fell between 0.921 and 0.997, while the average was 0.953.

	Per cents.	Sp. gravities.
1. Boston,	0.668	0.956
2. “	0.336	0.926
3. “	1.096	0.957
4. “	0.854	0.965
5. “	0.476	0.946
6. “	0.776	0.955
7. “	1.232	0.951
8. “	0.696	0.956
9. “	0.880	0.950
10. “	1.094	0.953
11. “	1.190	0.976
12. Fitchburg,	0.756	0.958
13. Salem,	0.864	0.960
14. Boston,	0.970	0.973
15. New Bedford,	0.960	0.954
16. “ “	0.840	0.955
17. “ “	0.840	0.952
18. “ “	0.424	0.934
19. Fall River,	0.866	0.961
20. “ “	0.590	0.953
21. “ “	0.816	0.975
22. “ “	0.782	0.959
23. “ “	0.440	0.966
24. Taunton,	1.100	0.963
25. “	1.090	0.960
26. “	0.946	0.959
27. Holyoke,	1.310	0.956
28. “	0.856	0.962
29. “	0.986	0.954
30. “ (Squibb's),	1.186	0.940
31. Northampton,	0.820	0.954
32. Greenfield,	0.868	0.958
33. “	1.080	0.962
34. Pittsfield,	1.080	0.959
35. “	0.670	0.959
36. “	1.634	0.965
37. Springfield,	0.610	0.932
38. “	0.786	0.955
39. Worcester,	0.626	0.957
40. Boston,	1.090	0.958
41. “	1.224	0.962
42. “	1.300	0.997
43. “	1.190	0.955
44. “	0.780	0.956
45. “	1.060	0.958
46. “	0.820	0.959
47. “	0.906	0.958
48. “	0.830	0.975

	Per cents.	Sp. gravities.
49. Boston,	0.926	0.959
50. “	0.810	0.930
51. “	1.080	0.961
52. “	1.870	0.964
53. “	1.160	0.977
54. “ (made from 13.72% Opium),	1.364	0.957
55. “	1.120	0.950
56. “	1.180	0 956
57. “	0.794	0.853
58. “	1 220	0.955
59. “	0.966	0.952
60. “	0.920	0.964
61. Chelsea,	1.700	0.967
62. East Boston,	0.860	0.968
63. Charlestown,	1.000	0.958
64. East Boston,	0.560	0.958
65. South Boston,	0.960	0.960
66. “ “	0.860	0.957
67. “ “	1.250	0.961
68. Chelsea,	1.250	0.960
69. “	1.056	0.958
70. Boston	1.126	0.966
71. “	0.906	0.992
72. Charlestown,	1.014	0.964
73. Boston,	1.710	0.972
74. “	1.316	0.997
75. “	0.540	0.949
76. Lowell,	0.886	0.972
77. Ashland,	0.904	0.954
78. Boston,	0.830	0.949
79. “	1.184	0.949
80. “	1.014	0.956
81. “	0.754	0,963
82. “	0.380	0.972
83. “	0.810	0 953
84. “	0.722	0.973
85. “	0.788	0.964
86. “	0.990	0.952
87. “	1.260	0.956
88. “	0.650	0.921
89. “	0.628	0.921
90. “	0.850	0.989
91. “ (made from 12.54% Opium),	1.295	0.949
92. “	1.090	0.956
93. “	1.085	0.956
94. “	1.140	0.960
95. “	1.100	0.958
96. My own make, uncorrected U. S. P. 1880 from 13.34 % opium,	1.290	0.953

	Per cents.	Sp. gravities.
97. My own make, corrected U. S. P. 1880 from 13.34 % opium percolating too fast	1.204	0.950
98. My own make, corrected U. S. P. 1880 from 13.34 % opium percolating better, ...	1 310	0.954
99. My own make, after U. S. P. 1870 from 13.34 % opium percolating too fast	1.084	0 963
100. My own make, after U. S. P 1870 from 13.34 % opium percolating better	1.108	0.964

Numbers 96–100 are the results of the very first attempts at percolation of one not a pharmacist, while numbers 54 and 91 were made by experienced pharmacists, and show the results attainable by proper skill. In all cases where notifications have been given that the examination of a sample has shown that the preparation was not being made of the proper quality, there has been found a very marked improvement in the next sample when obtained, thus proving that it could be made of a more satisfactory quality when desired.

Of Morphine salts 10 samples have been examined.

		Addresses.
1.	Morphine, free alkaloid, ...	Boston.
2.	Morphine Acetate “	Boston.
3.	“ Hydrochlorate	Boston.
4.	“ Sulphate, ...	Boston.
5.	“ “	Boston.
6.	“ “	Boston.
7.	“ “	Salem.
8.	“ “	Lawrence.
9.	“ “	Lynn.
10.	“ “	Haverhill.

And all were found to conform to the pharmacopœial requirements.

Of Powdered Cinchona Bark 20 samples have been examined.

Addresses.	Per cent. Total alkaloids.	Addresses.	Per cent. Total alkaloids.
1. Boston,	9.42	11. Boston,	2.92
2. "	3.85	12. "	3.72
3. "	3.20	13. "	6.41
4. "	6.04	14. "	2.46
5. "	0.98	15. "	2.24
6. "	1.30	16. Cambridge,	5.84
7. "	5.38	17. Roxbury,	1.98
8. "	2.44	18. Winchester,	2.53
9. "	4.79	19 Roxbury,	9.10
10. "	7.00	20. Boston,	7.65

Of these which were all bought as samples of good barks only 8, or 40 per cent. fell below the pharmacopœial minimum of at least 3 per cent. of total alkaloids.

Of the salts of the Cinchona alkaloids 28 samples have been examined, resulting as follows:—

			Of the other Alkaloids, by Kerner's test.
1.	Quinine Sulphate,	Zimmer's,	Excess.
2.	" "	Boeringer's,	No excess.
3.	" "	" & Guyer's,	" "
4.	" "		" "
5.	" "		Excess.
6.	" "		"
7.	" "		No excess.
8.	" "		" "
9.	" "		" "
10.	" "		Excess.
11.	" "	Chas. T. White's,	No excess.
12.	" "	P. & W.'s.,	" "
13.	" "	" "	" "
14.	" "	" "	Excess.
15.	" "		No excess.
16.	" "	Chas. T. White's,	" "
17.	" Alkaloid,	P. & W.'s.,	" "
18.	" Hydrochlorate,	" "	" "
19.	" Sulphate,		Much excess.
20.	" "		No excess.
21.	" "		" "
22.	" "		Much excess
23.	" "		" "
24.	" "		No excess.
25.	" "	Rosengarten's,	" "
26.	" Alkaloid,	"	" "
27.	" Sulphate,	Keasby & Mattison,	" "
28.	" "	P. & W.'s.,	" "

Thus 8 samples or 28.51 per cent. contained an excess of the other, and cheaper cinchona alkaloids. They lost upon fully drying at 100° C. from 2.5 to 10 per cent. of moisture. Thus none exceeded the pharmacopœial limit of 16.18 per cent.

Of Citrate of Iron and Quinine 40 samples have been examined with the following results :—

			Per cent. of Quinine.
1.	Boston,	Herring & Co., London,	3.00
2.	“		6 75
3.	“	P. & W.'s ,	10.75
4.	“		12.25
5.	“		6.75
6.	“		10.75
7.	“		8.63
8.	“	P. & W.'s.,	10.1
9.	“		10.08
10.	“		6.7
11.	“	Morson's,	9.65
12.	“	Rosengarten's Soluble,	9.75
13.	“		10.75
14.	“	Squibb's,	12.77
15.	“	Billings, Clapp & Co. warranted (U. S. P.),	10.58
16.	“	Rosengarten's,	11.00
17.	“	P. & W.'s.,	8.37
18.	Roxbury,		12.00
19.	Boston,		7.20
20.	Roxbury,	P. & W.'s.,	10.10
21.	Fitchburg,		11.20
22.	Boston,	Billings, Clapp & Co., “English Style,”	3.80
23.	“		7.90
24.	“		3.50
25.	“		11.55
26.	“		6.00
27.	“	McIntire & Embury Soluble (U. S. P.),	10.70
28.	“		14.37
29.	“	Schiefflin's Sol. 10 per cent ,	8.82
30.	“	Sent by Schiefflin to replace the above,	10.50
31.	“	Schiefflin's Sol. 10 per cent.,	10.17
32.	“		9.00
33.	“	Rosengarten's (Guaranteed U. S. P.),	7.70
34.	“	Squibb's,	12.87
35.	“	Billings, Clapp & Co., U. S. P.,	11.50
36.	“	“ “ “ “ English Style,”	10.00
37.	“	Schiefflin's U. S. P.,	12.50
38.	“	Rosengarten's & Sons, Soluble (with U. S. P. Quinine),	6.40
39.	“	McIntire & Embury (with U. S .P. Quinine),	10.88
40.	“	Rosengarten's Soluble,	10.00

Thus 34 samples, or 85 per cent., fell below the pharmacopœial quantity of 12 per cent. of quinine. Two samples, however, of these contained the full amounts claimed in their labels, being soluble 10 per cent. quinine preparations. Most of the others, although the pharmacopœial article had been called for, were the non-officinal form of this preparation, green and containing ammonia. This preparation, — in this State, at least, — has well-nigh wholly supplanted the U. S. P. brown scale form, and usually without any notice being made of it. The alkaloids obtained from the chloroform evaporations in the assays were, in most all cases, wholly soluble in about 30 parts of ether, thus excluding any very considerable proportion of the other cheaper alkaloids. Where enough of the scales was had, the alkaloidal residue was examined by the U. S. P. 1880 test for its purity as quinine. All the samples thus examined conformed to the requirements.

Of the Nux Vomica alkaloids, four samples of Strychnine have been examined, two being the free alkaloids and two sulphates, and all made by Powers & Weightman. Two of them gave slight traces of the presence of brucine, but conformed to the full requirements in all other respects.

Of powdered Jalap, which is often deprived of its resin, the active principle of this drug, 12 samples have been examined in regard to this particular. They gave the following results: —

	Per Cent. Total Resin.	Ether, soluble.
1. New Bedford,	21.9	5.95
2. Lee,	15.8	6.1
3. Boston,	10.8	2.4
4. Boston,	7.3	0.75
5. Fitchburg,	10.4	1.7
6. Holyoke,	4.6	0.9
7. Greenfield,	2.2	1.3
8. Taunton,	12.1	0.3
9. Fall River,	7.75	0.05
10. Newton,	1.1	0.1
11. Boston,	11.25	1.35
12. Boston,	11.7	1.75

Thus but one only conformed to the U. S. P. 1880 requirement of yielding not less than 12 per cent. of resin, of which not over 10 per cent. should be soluble in ether.

Of Beeswax, four samples were examined, two each of the yellow and of the white. Three of them were found to contain paraffin.

One sample each of Caffeine and of Picrotoxin, both made by Powers & Weightman, were examined and found to conform to their proper requirements.

Six samples of Chloroform were examined, with the following results: —

			For. Cl. Comp.	Empyreumatic.
1.	Newton,		0	+ *
2.	Fitchburg,		0	+
3.	Boston,	Powers & Weightman's,	0	+
4.	"	Pfizer's,	0	0
5.	"	Squibb's,	0	0
6.	"		0	0

Thus half had the required freedom from empyreumatic oils, and all from foreign chlorine compounds.

Two samples of Alcohol were obtained from B. O. Wilson and J. A. & W. Bird, both wholesale dealers of Boston, and both samples conformed to the requirements.

Two samples of Ether were obtained from Carter, Harris & Hawley, made by Powers & Weightman and by E. R. Squibb, and both were found to conform to the requirements.

Ten samples of Creasote were examined, and six of them proved to be crude carbolic acid: —

			True Creasote.	Crude Carbolic Acid.
1.	Boston,	Morson's,	+	-
2.	"	Rosengarten's,	+	-
3.	"		-	+
4.	"	Rosengarten's,	+	-
5.	"		+	-
6.	"		-	+
7.	"		-	+
8.	"		-	+
9.	"		-	+
10.	"		-	+

* NOTE. 0 = absence of impurity.
+ = presence of "

Of the pharmacopœial Acids, the following 35 samples have been obtained and examined, with these results : —

1.	Acetic,	Boston,	P. & W.'s, equalled U. S. P.
2.	"	"	Squibb's " "
3.	Oxalic,	"	contained non-volatile bases.
4.	"	"	Merk's equalled U. S. P.
5.	Benzoic,		P. & W.'s " "
6.	Citric,		" " "
7.	"		" " "
8.	Hydrobromic dil.	"	contained K H $\bar{T}$, and was 30.36 per cent of U. S. P. strength.
9.	" "	"	contained K H $\bar{T}$, and was 47.45 per cent. of U. S. P. strength.
10.	" "	"	contained K H $\bar{T}$, and was 42.55 per cent. of U. S. P. strength.
11.	Hydrocyanic dil.	"	Squibb's, contained 1.41 per cent. H. Cy.
12.	" "	"	" " 1.55 " "
13.	Phosphoric,	"	Morson's, contained 134 per cent. of U. S. P. strength.
14.	Salicylic,	"	equalled U. S. P., except in excess of organic matter.
15.	"	"	equalled U. S. P.
16.	Tannic,	"	equalled U. S. P.
17.	"	"	was not the U. S. P. acid.
18.	Tartaric,	"	equalled the U. S. P.
19.	"	"	" " "
20.	"	"	" " "
21.	"	"	" " "
22.	"	"	" " "
23.	"	"	" " "
24.	"	"	" " "
25.	"	"	" " "
26.	"	"	" " "
27.	"	"	" " "
28.	"	"	" " "
29.	"	"	" " "
30.	"	"	" " "
31.	"	"	" " "
32.	"	"	" " "
33.	"	"	" " "
34.	"	"	" " "
35.	"	"	" " "

Seven, or 20 per cent., fell below their proper strength or quality.

Four samples of Alum were examined : —

1. Boston, was ammonia alum.
2. " " " "
3. Boston, was potassium alum.
4. " " Squibb's iron alum.

Two of these were not the pharmacopœial alums.

Ten samples of pharmacopœial Ammoniacal Salts were examined : —

1. Bromide, P. & W.'s, equalled the U. S. P.
2. Iodide, " " "
3. Chloride, " had excess of iron and organic matter.
4. " Squibb's, " " " ".
5. " Rosengarten & Son, had excess of $H_2 S O_4$.
6. Carbonate, did not equal the U. S. P.
7. Chloride, equalled the U. S. P.
8. Sulphate, Merk's, equalled the U. S. P.
9. Chloride, had excess of Fe. and organic matter.
10. Benzoate, equalled the U. S. P.

Five, or half of them, conformed to the requirements : —

Of the pharmacopœial Antimony preparations, a Purified Sulphide and a Tartar Emetic were examined, and both equalled the U. S. P.

Six samples of the Silver preparations were examined, — a Cyanide, Iodide, Nitrate and an Oxide, all made by Powers & Weightman ; a Nitrate, by Rosengarten & Son, and a Fused Nitrate, by Squibb. All conformed to the U. S. P.

Of Bismuth preparations, six samples were examined. Two of these contained a slight trace of arsenic, but were otherwise correct.

Of Reduced Iron, six samples were examined, and four of them had less than their proper amounts of metallic iron.

Of Tincture of Chloride of Iron, ten samples have been examined. None of them agreed fully to the U. S. P. standard, yet they did not differ materially therefrom. The same was true of two samples of the Solution.

Eight samples of the organic acids scale Salts of Iron, simple, and with ammonia and potassium, that were made by Powers & Weightman, Rosengarten and Squibb, all agreed practically with the Pharmacopœia; likewise with one sample of the Solution of the Citrate.

Four samples of Calomel all agreed with the Pharmacopœia.

Ten samples of the Solution of Soda ranged in strength from 75 to 122 per cent. of the pharmacopœial strength, five of them falling below 100 per cent.

Six samples of Magnesia preparations, including the Oxide, Carbonate, Sulphate, and two solutions of the Citrate, all conformed to their standards.

Of Bromide of Potassium ten samples have been examined.

Makers.

1. Chas. T. White, had an excess of moisture, carbonates and chlorides.
2. Rosengarten & Son, " chlorides.
3. Billings, Clapp & Co., " moisture and chlorides.
4. Chas. Pfizer, " chlorides.
5. Powers & Weightman, " moisture, carbonates and chlorides.
6. Of unknown make, had but a trace of excess of carbonate and chlorides.
7. Chas. T. White's, had but a slight excess of chloride.
8. Powers & Weightman, had small excess of alkali and of chloride.
9. Unknown, had excess of alkali, bromate, sulphate and chloride.
10. " " " " " " " " "

Thus none of the ten conformed to the full requirements of the U. S. P. 1880. This is partly explainable by the senseless trade custom of demanding that the salt shall appear in white, opaque crystals instead of the purer form of colorless translucent crystals of a neutral reaction.

Of Iodide of Potassium ten samples have been examined.

Makers.

1. Powers & Weightman, had excess of chloride or bromide.
2. Unknown, had excess of alkali and chloride or bromide.
3. " " " " of chloride or bromide.
4. Rosengarten & Son, had excess of alkali and of chloride or bromide.
5. Unknown, had excess of alkali and of chloride or bromide.
6. Powers & Weightman, had excess of alkali, iodate, chloride or bromide, and sulphate.
7. Rosengarten & Son, had excess of alkali, chloride or bromide, and sulphate.
8. Unknown, had excess of alkali, iodate, chloride or bromate.
9. " had excess of alkali, chloride or bromate.
10. " had excess of alkali and of chloride or bromate.

Thus none fully conformed to the requirements of the pharmacopœia, and this is partly explainable for the same reason as with the bromide. The trade should understand that the form of crystals they demand cannot be pure, and that the excess of alkali, necessarily present, renders it totally unfit for use in many combinations.

Of Tartrate of Potassium, two samples have been examined. One of them had a pharmacopœial excess of lime present.

Of the Bitartrate of Potassium or Cream of Tartar, four samples have been examined, and but one of them had an excess of lime.

Four samples of the Chlorate, two of the Nitrate, and four of the Citrate of Potassium were examined and all found to be of their proper quality.

Of Compound Effervescing, or Seidlitz Powders, twenty samples have been obtained and examined.

		Wt. in Grammes	
		of alkaline.	of acid powder.
1.	Boston, ...	10.82	2.67
2.	"	9.31	2.04
3.	"	8.47	2.84
4.	"	9.39	3.57
5.	"	11.45	3.77
6.	"	10.79	2.65
7.	"	12.24	3.43
8.	"	11.40	2.22
9.	"	8.15	2.49
10.	"	9.06	3.10
11.	"	7.79	3.62
12.	"	8.39	1.82
13.	"	11.59	2.77
14.	"	9.12	3.23
15.	"	10.52	2.30
16.	"	10.70	2.46
17.	"	11.22	2.76
18.	"	10.56	2 53
19.	"	9 32	2.13
20.	"	8.40	1.95

According to the Pharmacopœia, the alkaline powder should weigh 10.33 gms. and the acid 2.25 gms. Eleven samples or 55 per cent. of the above fell short in weight, while in one case, the tenth, the acid was replaced by an alkaline powder somewhat heavier than the acid should have been. This substitution, however, was probably merely accidental. The powders were all otherwise of fair quality, and much of the variation in weight is probably owing to the prevailing custom of making up the powders by measuring rather than by actual weighing.

Four samples of Tartrate of Potassium and Sodium, or Rochelle Salt were examined, and all found to conform to the requirements.

Four samples of Borate of Sodium or Borax were examined and found to be of good quality, except one put up as a powder in boxes by Chas. F. Risley of New York City. This was found to contain a large admixture of bicarbonate of soda of a cheap quality.

Five samples of Bicarbonate of Sodium were obtained.

1. Boston, satisfied the U. S. P.
2. “ had an excess of chloride and carbonate.
3. “ satisfied the U. S. P.
4. “ had an excess of chloride and carbonate.
5. “ Merk's make, satisfied the U. S. P.

Two of them contained large excess of the chloride and the carbonate.

Four samples of Salicylate of Sodium were obtained.

1. Powers & Weightman, satisfied the U. S. P.
2. Rosengarten & Son, “ “ “
3. E. Schering, “ “ “
4. E. R. Squibb, “ “ “

All were of the pharmacopœial quality.

Two samples of Phosphate of Sodium were obtained and found to be of pharmacopœial quality.

Fifteen samples of Precipitated Sulphur were obtained.

1. Boston, of acid reaction but otherwise satisfactory.
2. “ “ “ “ “ “ “
3. “ was only sublimed sulphur.
4. “ “ “ “ “
5. “ “ “ “ “
6. “ contained of gypsum 59.2 %
7. “ “ “ “ 56.75 “
8. “ “ “ “ 53.7 “
9. “ “ “ “ 57.9 “
10. “ “ “ “ 56.0 “

11. Boston, contained of gypsum 57.3 %.
12. " " " " 66.5 "
13. " acid but otherwise pharmacopœial.
14. " only sublimed sulphur.
15. " " " "

All contained free acid, but in other respects 12 samples, or 80 per cent., were not the precipitated sulphur of the pharmacopœia. The presence of the gypsum is probably explainable by sulphuric acid having been used in its manufacture, instead of hydrochloric as directed by the Pharmacopœia.

In making microscopic examination of powdered drugs my standards of comparison have been powders prepared by myself from fair samples of the drug selected with the kind aid of Mr. B. O. Wilson of the well-known firm of B. O. & G. C. Wilson, botanic druggists of Boston, and supplemented by samples of his own milling, which having been prepared from larger quantities of the drugs than those prepared by myself in my hand mortar, might be considered as more fairly representing the standard to which a commercial sample should conform. The many very elaborate works upon the anatomical structure of the drugs of the German pharmacopœia are a most important aid in this kind of examination.

At the time of making the collections of most of the following powders, as the orders were, primarily, to find out the condition of the market as regards the prevalence of adulterations, a record was not kept of those from whom they were obtained.

The following 192 samples of 26 different kinds of powdered officinal drugs were examined microscopically, and 39 of them found to be adulterated in the following manner, judged solely upon their histological appearances.

Powdered.	No. Pure.	No. Adulterated, and manner.
1. Acacia, . .	6.	
2. Belladonna leaves,	3.	
3. Buchu, . .	2.	
4. Capsicum, .	8.	1, with an unrecognized material.
5. Cardamom, .	2.	
6. Caryophyllus, .		2, oil removed.
7. Cassia, . .	2.	
8. Cinnamon, .	1.	2, cassia substituted.

Powdered.	No. Pure.	No. Adulterated, and manner.
9. Coccus,	3.	
10. Cubebs,	5.	
11. Ipecac,	30.	5, wheat flour added, and starches.
12. Jalap,	12.	11, resin deficient.
13. Liquorice,	5.	
14. Lupulin,	2.	
15. Lycopodium,	6.	
16. Macis,	2.	1, oil removed and flour added.
17. Maranta,	6.	1, potato starch substituted.
18. Myristica,	2.	
19. Myrrh,	3.	
20 Pimenta,	2.	
21. Piper,	4.	[poor.
22. Rhubarb,	23.	No foreign material, but many evidently
23. Saffron,	1.	2, safflower substituted.
24. Senna,	7.	1, with an unrecognized material.
25. Ulmus,	11.	13, with wheat flour.
26. Zingiber,	5.	

But for the adulteration of powdered drugs it is not commonly now, as formerly, that totally foreign substances are introduced, but it is the closely allied, and inferior varieties, or damaged samples of the very same drug that are used. Drug millers now study structural botany, and are becoming as expert as those whose official duty it is to expose their improper practices. Millers often excuse themselves for their admixtures by the too well known fact that most druggists require as many pounds of the powdered drug to be returned to them from the mill as they sent to it in crude drug; refusing to allow any, or the full proper amount for the well-known inevitable loss incident to the necessary drying and subsequent powdering of the drug. Then too they contend, and with much show of reason in so far as druggists themselves are concerned, but not so with the uninformed public at large, that there is no deceit practised in offering upon the same price list as in the following examples. From the October price list of J. Domergue & Co., Importers and Dealers in Drugs, 13 Gold Street, New York.

' Red Bark, select, large pieces,	$0.50 to $1.00
' " " powdered, pure,	.16 to .18.
Rhubarb, for cutting, select,	.75 to .90.
" good round or flat,	.65 to .75.
" powdered, pure,	.25 to .35."

From the Feb. 25, 1882, Price List, for Spice Mills only, of Beard & Howell, Importers and Manufacturers of Spices and Mustards, 5 to 9 James Slip, New York.

	cts.
" Strictly pure Trieste Flour, B. & H., Mustard in Barrels,	21.
Anchor Brand,	16.

Mixtures.

	cts.		cts.
Black Pepper,	2¾.	Cloves,	3.
White "	3.	Cinnamon,	4.
Cayenne "	4.	Nutmegs,	5.
Ginger,	2¾.	Mace,	5.
Allspice,	3.	Mustard,	4.

Our "Strictly Pure Mustards" are all *absolutely* without *artificial color*. We can furnish colored mustards to suit the demand and make them to match samples, or as high color as any may desire, without any additional charge. Shall be very happy to forward samples of our goods, and will always name the lowest possible price in keeping with the very superior quality of the goods. We guarantee *goods as represented* or *no sale*."

Certainly by such a price list as the last, which was sent to a Boston druggist, no reasonable person could be deceived, or expect to find anything but total absence of the true spices named in the list of mixtures, as is the fact, although they are very close imitations, so far as their gross external appearances are concerned.

Besides the above 680 samples of pharmacopœial drugs, I have, during the year past, examined for the Board the following 8 samples of proprietary cough syrups, and preparations used therein, for the amounts of hydro-cyanic acid which they might contain, with the following results: —

Ayer's Cherry Pectoral had 0.005 of 1 per cent.
Wistar's Balsam of Wild Cherry, hardly any trace.
Boschee's German Syrup of Tar and Wild Cherry, hardly any trace.
Wiggin's Cherry Cordial had 0.0075 of 1 per cent.
Sproat's Syrup of Tar had 0.011 of 1 per cent.
Oil of Bitter Almonds, 6 per cent.
S. A. D. Sheppard's Syrup of Wild Cherry, 0.003 of 1 per cent.
" " Cough Syrup composed the half of the above, 0.001 of 1. per cent.

These very small percentages thus sustain the assertion of Dr. E. R. Squibb of Brooklyn, N. Y., in the September, 1883, number of his "Ephemeris" in which he says, when speaking of hydrocyanic acid: "How it can by any possibility be of any use in some complex prescriptions into which it enters—especially in such heterogeneous mixtures as 'chlorodyne,' it is difficult to understand, and the probability is that it is decomposed so rapidly that in a few days it could not be found." The oil of bitter almond, however, even when freed from the prussic acid present in the crude oil, by decomposition or otherwise, still retains the peculiar taste and smell as before, for this does not depend upon the presence of the acid.

I have thus far acted for the Board as expert in seven prosecutions for violation of the adulteration act. In all of these the fact of an adulteration existing has been proved, although in the first and last case the defendant escaped being held therefor. The cases were as follows: —

1. For a sale of a sample of Tincture of Opium, or Laudanum, which assayed but 0.81 of morphine strength, instead of the proper 1.20 per cent. A previous sample had assayed but 0.54 per cent. The court found "that the drug which was sold at the defendant's store was adulterated, but that on the evidence it did not appear that the party who sold the drug was an authorized salesman." The defendants were therefore discharged. The young man employed as collector of samples, in his confusion, for the first time experiencing a legal cross-examination, had neglected to mention in his evidence that the clerk making the sale, on taking the written order for the drug, had consulted with the senior member of the firm, who was present, before filling it.

2. For a sale of a sample of Laudanum which assayed only 0.79 per cent. of morphine, instead of the 1.20 per cent. A previous sample had assayed only 0.69 per cent. The court found the defendant guilty.

3. For the sale of a sample of Citrate of Iron and Quinine, which assayed but 7.9 per cent. of quinine instead of the proper 12 per cent. A sample obtained the month before had assayed but 3.8 per cent. The court found the de-

fendants guilty and they appealed. But the appeal has been withdrawn and the fine paid.

4. For the sale of a sample of Laudanum which assayed but 0.72 per cent. of morphine, instead of the proper 1.20 per cent. Found guilty, the defendants appealed, but it has been settled with the preceding case.

5. For the sale of a sample of Laudanum which assayed but 0.38 per cent. of morphine, instead of the proper 1.20 per cent. A previous sample had assayed but 0.56 per cent. Found guilty, the defendant appealed, but next day withdrew it and paid his fine.

6. For the sale of a sample of Laudanum which assayed but 0.63 per cent. of morphine. Previous samples had assayed only 0.65 and 0.81 per cent. Found guilty the defendants appealed, but afterwards withdrew the appeal and paid the fine.

7. For the sale of a watered cider vinegar having an acidity only equivalent to 3.66 per cent. of acetic acid, and a residue of only 1.4 per cent., the government's analyst having never been able to find a pure cider vinegar which had less than 6 per cent. of acidity and 1.8 per cent. of residue, the average being 6.6 per cent. for acidity and 3.3 for solid residue. The defendant, when upon the stand, confessed to the having at times watered his cider vinegar, and during the period in which he asserted that this particular sample was made, although he denied having done it to this sample. An expert for the defence, stated that he agreed with your analyst in his assay of this particular sample, and that it fell below anything that he had himself ever assayed, even when he was seeking for the poorest possible, and confessed that it was in his opinion a very suspicious sample for a pure apple cider vinegar as claimed. The court ruled that proof of guilty knowledge was necessary for one to be held for a crime, and that he should always require it to be shown, although it might not be required in a statute itself, and discharged the defendant.

None of the cases prosecuted thus far have pushed the enforcement of the law to its possible extent, but there has always been left the very broad margin of over 30 per cent.

of variation in the most important constituent from the proper standards, even in the highest samples, and this too always after, at the least, a second detected violation of the statute. There is undoubtedly a point beyond which any variation in material elements would seem to be explainable only by intent, or else by carelessness, or ignorance so gross as to be blameworthy when occurring in an article so needful to be exactly of its proper strength as a medicine. Either excess or deficiency here may be equally and fatally harmful. In the first case from want of the proper action in the emergency, and in the second case from excess of action, if taken in the accustomed dose, more especially if this has become unwontedly increased from previous lack of the proper strength in the medicine.

Respectfully submitted.

BENNETT F. DAVENPORT,

Analyst.

TRICHINOSIS.

TRICHINOSIS.

In the month of April of the present year the State Board received notice of the existence of some cases of Trichinosis in the city of Brockton. The following account of these cases was furnished by the attending physician, Dr. J. H. Averill: —

"March 27, 1884. Was summoned to attend a family named Sandburg, natives of Sweden, who had lived in the United States a year. The husband, wife and oldest son, aged respectively 35, 30 and 8 years, were ill in bed. They were taken ill about the same time, four or five days earlier. All had felt tired and languid for several days, and were œdematous about the eyes and face. The mother was quite generally œdematous from head to foot. All complained of general pains, headache, lassitude. Muscles were sore and painful when touched or moved. Limbs flexed, extension caused great pain. The father complained of pain across the thorax; the mother had marked abdominal tenderness. All had a temperature of about 102½° F.; pulse soft and quick, about 125 per minute. Tongues red, trembling, and protruded with difficulty and pain. Mrs. S. had dimness of vision. All had slight cough, no diarrhœa or vomiting. Kidneys acted freely and with a normal secretion.

"The surroundings of the house were in fair condition, drinking-water apparently good, and the family reasonably neat.

"March 31. Mr. and Mrs. S. were worse. High pulse and temperature continued. Respiration labored, — 40 per minute.

"Learned that about two weeks before they were taken ill, they had purchased half of a smoked ham, and had eaten portions of it uncooked several times during the week following its purchase. These three persons had all partaken of the raw meat, while three younger children had not eaten it and were not affected.

"A family occupying another tenement in the same house had purchased the other part of the same ham, and while preparing breakfast the father ate a piece of the raw ham. He also was taken ill, and had a similar train of symptoms with the other family, but in a milder degree. He had muscular pain, lassitude, œdema, vomiting and diarrhœa. Was ill about two weeks. His wife did not eat any of the raw meat and was not ill.

"April 1. Mr. and Mrs. S. were still very ill. Mr. S. had difficulty in standing or moving, on account of excruciating pain. Mrs. S. also had intense pain on slightest motion. Muscles were hard, swollen and tender. No sleep, day or night."

In the case of the Sandburg family, the infection was at its height about April 3, after which date there was gradual improvement and finally complete recovery.

These people were visited by a member of the Board, together with the health officer, on April 7, and the evidence presented to them was sufficiently conclusive as to the identity of the disease, although none of the suspected meat had been saved for examination.

The international discussion which has recently arisen with relation to this subject, together with the proposition for more stringent enactments relative to the traffic in American pork, has awakened a new interest in the matter.

A circular was received by the Health Department in January last as follows: —

SPECIAL COMMISSION ON AMERICAN PORK APPOINTED BY THE PRESIDENT OF THE UNITED STATES.

With a view to ascertaining the extent to which trichinosis prevails in the United States, the following questions have been formulated, to be addressed to the secretaries of the various state and city boards of health.

As it is desirable that the report of the commission should be presented to Congress at once, the undersigned would beg as speedy a response as possible :—

1. How many cases of trichinosis have come to the knowledge of your board? Please give dates, as far as practicable.

2. In how many cases was there a microscopic identification of the trichinæ in the human subject and in the suspected meat?

3. How many of the cases were fatal?

4. Have any cases of meat poisoning, other than by trichinæ, come under your observation? If so, how many, and of what nature?

Yours respectfully,

Geo. B. Loring,
C. F. Chandler,
D. E. Salmon,
} Commission.

Address reply to Geo. B. Loring,
Commissioner of Agriculture, Washington, D. C.

To this circular the following reply was sent : —

State Board of Health Lunacy, and Charity.
Department of Health,
State House, Boston, *Feb. 16, 1884.*

Sir : — In reply to your circular, entitled a "Special Commission on American Pork," I have the honor to state : —

First question. Nineteen cases in all.

Date.	Place.	No. of Cases.	Deaths.
February, 1870,	Saxonville,	3	1
March, "	Lowell,	6	–
December 1872,	Framingham,	3	–
May, 1873,	Becket,	4	–
March, 1880,	Wakefield,	3	–
		19	1

Second. Identification of trichinæ was made in the fatal case at Saxonville, by post-mortem. In the Lowell cases, trichinæ were identified in the pork, and also in those at Framingham. In the seven remaining cases at Becket and at Wakefield, the evidence was symptomatic only, and by exclusion, *i. e.*, members of families who had not partaken of uncooked pork, were exempt from infection. The evidence, however, in regard to such infection was satisfactory to the Board.

Third. One case fatal at Saxonville.

Fourth. No other cases of meat poisoning, except by putrid or decomposed meat.

In addition to the replies to questions above stated, I respectfully call your attention to the reports of the board, containing records of investigations relative to the presence of trichinæ in swine. (*Public Health Supplement, First Report of State Board of Health Lunacy and Charity.*) In that report Dr. F. S. Billings, V. S., states that he had examined 2,701 hogs, of which number 154 were found infected with trichinæ, or in the ratio of 1 to 17.5. A subsequent report by Dr. Billings (3d annual report H. L. and C., page xlvi) gives the results of an examination of 6,068 hogs, of which 191 were found infected, or 1 in 31.7. These examinations were made upon hogs slaughtered in the neighborhood of Boston in the years 1879 and 1880, most of the animals having been received from Western States.

In addition to these, 500 hogs have been examined by Prof. Mark, of Harvard University, since Oct., 1881, with the following result:—

Localities from which Hogs were received.	Number Examined.		Number Trichinous.		Total Examined.	Total Trichinous.	Per Cent. Trichinous.		Total.
	Male.	Female.	Male.	Female.			Male.	Female.	
Chicago, ...	163	133	-	4	296	4	-	-	1.35
Michigan, ...	35	39	-	-	74	-	-	-	-
Cincinnati, ...	40	32	1	4	72	5	-	-	6.9
Pittsburg, ...	3	31	-	-	34	-	-	-	-
Domestic, near Boston, . .	9	15	-	1	24	1	-	-	4.17
	250	250	1	9	500	10	.4	3.6	-

Nine specimens were taken for examination from each animal, from the pillars of the diaphragm. Fifty other hogs were also examined (Chicago hogs) from which three slips only were taken in each case, the result being entirely negative.

Respectfully, yours,
Saml. W. Abbott, *Health Officer.*

Hon. Geo. B. Loring,
Commissioner of Agriculture, Washington, D. C.

This entire list of twenty-three cases (including the recent cases at Brockton), with one death only in a period of fifteen years, is small, when compared with the State's population of nearly two million inhabitants. Even this comparatively small number might have been prevented had the afflicted parties heeded the precautions so often published.

In the work of examination of American hogs, systematic work has not been uniformly done throughout the United States. Here and there occasional inspections have been made, under the supervision of state, local, or private authorities. The total number of these examinations reported in the United States up to the present year has been 18,889, of which 517 or 2.7 per cent. were found infected. Of the whole number, 9,269, or nearly one-half, were examined in Massachusetts, and of these, 355 were found infected, or 3.8 per cent., — one hog in 26. The entire number of examinations of American pork, at home and abroad, up to the present year, as reported by the Department of Agriculture, amounts to 298,782, of which 6,280 were infected, a ratio of 2.1 per cent., or 1 in 48.

Pork is usually submitted to one or more processes previous to its use as food. These are chiefly, *salting*, *smoking*, and *cooking*.

1. *Salting*. This process, although thoroughly done, that is, with a strong brine in which the pork is immersed and submitted to the action of the salt in solution for an extended period, has not been shown to be invariably fatal to trichinæ. The greatest caution should therefore be observed, especially in the use of the central portions of large pieces of meat, unless a long period has elasped since they were first placed in strong brine.

On the other hand, in support of the assumption of the fatal effect of salting upon trichinæ in pork, may be adduced the immunity of the workmen who have, for many years, been employed in handling the packages of salted pork on their receipt in European ports. "These men," says Dr. Gibert, of Havre, "are in the habit of eating freely of the raw, salted pork, often making a breakfast upon the raw, salted ham or bacon. They have even been known to eat pieces of salted pork which had been pronounced to be trichinous." Notwithstanding, no cases of trichinosis have ever been known among them.

On the other hand, the experiments of Chatin, who fed rats and other small animals with American pork, raw and salted, known also to be trichinous, appear to show that infection with such meat is possible.

The element of time is worthy of consideration in this connection. A period of at least a week, and usually much longer, elapses between the salting of the meat in the United States and its receipt in European ports.

In the absence of more definite experimentation in regard to the effect of salt solutions of definite strength on trichinous pork, reliance should not be placed in this process as a sure preventive of infection.

2. *Smoking.* The process of smoking, which is practised generally throughout the United States is not fatal to trichinæ. The greater number of cases of illness due to trichinæ in the United States have resulted from the eating of raw, smoked ham.

3. *Cooking.* The importance of thorough cooking of all pork has already been urged in former reports of the Board. Experiments in this direction having led to somewhat variable results, it is safe to follow the highest temperatures recorded. Vallin, in some experiments conducted with boiled meats, found that a temperature of 60° C. (140° F.) was necessary to destroy trichinæ. These were made with small bits of trichinous meat, boiled in glass tubes. His experiments were confirmed, with but slight variations, by those of Fiedler and Leuckart, Fiord and Davaine. Further experiments with hams weighing 12¾ and 11¼ pounds boiled in five gallons of water, showed that a temperature of 60° C. (140°F.) was not reached at a depth of 8 centimeters (3.15 inches) from the surface of the ham, until three hours had elapsed.

Hein found that a roasting-piece, reached a temperature of 69° C. (156° + F.) after one and a half hours roasting. Rupprecht observed a temperature of 53.5° C. (128° F.) in the interior of rapidly fried sausage, which was still capable of infection.

In October last, the severest epidemic of Trichinosis yet on record occurred in Saxony in three small villages, with an aggregate population of 1,400 inhabitants. These were neighboring villages a few miles apart. There were also a few cases (8) in the neighboring town of Groningen.

The cases as reported were as follows : —

In Emersleben there were	270	cases and	53	deaths.
" Deesdorf " "	45	" "	10	"
" Nienhagen " "	80	" "	1	"
" Groningen " "	4	" "	2	"
" Kloster Groningen there were	3	" "	–	"
" Schwanebeck " "	1	" "	–	"
Total	403	" "	66	"

During the height of the epidemic Drs. Brouardel and Grancher of the Academy of Medicine of Paris visited Emersleben, and have published the results of their observation.

A pig was purchased at the little village of Nienhagen Sept 11, 1883, by a butcher, who took it to his home in the neighboring village of Emersleben, and killed it on the following day, Sept. 12. He gave slices to two of his neighbors, who hashed or minced the meat, and ate the same raw on the 13th. These two were taken ill on the 16th, and both died; one Oct. 14, the other Oct. 21.

These were the only persons who partook of the meat of the affected hog, unmixed with the flesh of any other animal of the same kind.

According to a prevailing custom among the butchers of that district, the butcher minced the flesh of this hog which he had killed Sept. 12, and mixed it with the meat of another hog, and sold the mixture to his customers on the following seven days, Sept. 13th–19th; the mixture being salted.

All of the consumers except five partook of this hashed and salted pork, raw, after spreading it upon bread according to a common custom. The five persons specified, members of the magistrate's family, ate the meat in the shape of sausages, which had been boiled. The cook in the same family ate some raw, and was severely ill.

Dr. Brouardel in his investigation of this epidemic professes to have established a point hitherto unnoticed, that the severity of the attack diminishes as the time elapsing between the killing and the eating of the pork increases.

The following table is introduced in support of this proposition as shown by the epidemic at Emersleben: —

September, 1883.

Day of month,	13	14	15	16	17	18 and 19
Day after pig was killed,	1	2	3	4	5	6 and 7
Number of deaths,	9	7	12	13	1	–
" severely affected,	12	14	19	28	3	4
" lightly affected,	6	23	25	58	6	10
Per cent. of deaths,	**33**	**16**	**21**	**13**	**10**	–
" severely affected,	44	32	34	28	30	28
" lightly affected,	23	52	44	59	60	72

It is a question of importance, whether the comparative innocuousness of the pork which M. Brouardel attributes to the lapse of time after the killing, may not rather be due to the salting of the hashed meat which the butcher is known to have practised, and which is admitted in a note by Dr. Brouardel.*

In view of this it would not be safe to trust to this statement as to lapse of time until similar observations had been made in the case of trichinous pork which has not been salted. The question of the effect of salting upon trichinæ has a more important significance when considered in its relation to the export of American pork to other countries.

National habits pertaining to the preparation, the cooking and the eating of meat, have an important bearing upon the prevalence of trichinosis in the human subject. The two neighboring countries, France and Germany, present two extremes, both in their habits as to the preparation and cooking of food, and also as to the prevalence of trichinosis among their inhabitants. While the United States, with a large proportion of foreign inhabitants, occupies a middle ground, with a comparative immunity from the disease.

1. *France.* But one epidemic is recorded as having occurred in France, in which 16 persons were attacked, and

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* P. 21, L'Epidemie d'Emersleben, Paris, 1884.

one died. This outbreak took place at Crepy en Valois in 1878. The offending animal was a native hog.*

2. *United States.* In this country, so far as can be learned from the replies of State and local boards of health to the government commission recently appointed, the entire number of reported cases amounts to but 145, with 29 deaths. This number is small when compared with the total population of fifty millions, and its insignificance is still more apparent when it is known that in most of the reporting States the figures embrace a period of fifteen or twenty years.

It may not be deemed amiss to point out some omissions in the report of the Government Commission. The report of Dr. Geo. Sutton upon Trichinosis in Dearborn County, Indiana, is quoted with reference to the prevalence of infection in hogs in that county; but no reference whatever is made to the cases of illness and death which occurred. Ten cases and three deaths occurred, and the diagnosis was confirmed both by examination of the pork, and by autopsies upon the deceased victims, and by the effect of the pork when fed to a dog.

A case was reported at the Bellevue Hospital in 1881, and was verified by section of the muscles during life.

Cases were reported by Dr. Germer, of Erie, Penn., in December, 1880, in the family of Charles Veith. Six persons were attacked. The pork of which they had eaten was examined, and found infected.

The family of George Lawrence in Springfield, Ill., were taken ill in January, 1881. In this case also the pork was examined, and shown to be trichinous.

Doubtless some cases, and especially when occurring singly, occasionally elude the diagnosis of the attending physician. A patient once died at the Massachusetts General Hospital of hernia, without any previous history of trichinosis. An autopsy being made, his muscles were found to contain many encysted trichinæ. Other similar instances are on record.

At least five important States had no State Boards of Health at the date of the Government report, — Pennsylvania, Ohio, Virginia, Maine and Vermont; and yet three of these are included in the report among those which are said to have returned negative replies.

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* Gazette des Hopitaux. Feb. 20, 1879.

Even including these few omissions and errors, it is doubtful if records of two hundred cases could be found as having occurred in the United States during the past quarter of a century.

In a recent treatise upon this subject Chatin has collected the data of ninety-one epidemics, occurring in a period of twenty-three years. Of this number, more than two-thirds occurred in Germany, while eight only are reported from the United States. The absurdity of the author's comment upon the frequency of trichinosis in the United States is apparent, especially when considered in connection with the list which immediately precedes it.*

3. *Germany.* If individual cases are made the basis of statistics instead of groups or epidemics, the German cases would constitute a much larger proportion of the whole, since the average number in each epidemic was much larger than in other countries, in some cases numbering hundreds, while in the United States no epidemic has ever been reported in which more than a dozen or fifteen people were ever infected at the same time.

In a period of seven years only (1877–1882) 1,835 people are known to have been infected in Germany, notwithstanding the existence of an army of meat-inspectors (18,000). In one small portion of the Empire, not so large as Massachusetts, including parts of Hanover and of Saxony, more than a thousand cases of trichinosis have occurred, none of which were traceable to American pork. The terrible epidemics of Hedersleben, Merseburg, Hettstadt, Brunswick and lastly of Emersleben are too well known to require repetition. Of these the small village of Hedersleben lost 101 out of 337 infected, and Emersleben 66 out of 403, as shown above. The gross habits which alone could admit of such outbreaks are almost unknown in France and the United States.

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* "En Amérique, il ne se passe guère de semaine où les journaux n'enregistrent quelque fait semblable aux suivants."

In view of the foregoing brief summary of some of the more recent investigations relating to Trichinosis, nothing further need be said than to reiterate the oft-repeated caution of former reports of this Board. *Eat no pork which has not been subjected to long and thorough cooking.* In this connection it has been shown that large hams, and pieces of pork of ordinary size, may be boiled for several hours without raising the temperature of their internal portions to a sufficient degree to destroy the vitality of trichinæ. There is therefore a greater security in the use of small pieces for cooking, than of large pieces, under like conditions.

CERTAIN QUESTIONS

RELATIVE TO THE

SEWERAGE AND THE SANITARY CONDITION OF NANTUCKET.

CERTAIN QUESTIONS

RELATIVE TO

The Sewerage and the Sanitary Condition of Nantucket.

In the Fifth General Report of the State Board of Health, Lunacy and Charity, page lxix, reference was made to the question of sewerage for the town of Nantucket.

In consequence of the action of the town of Nantucket at a public meeting, the State Board of Health, Lunacy and Charity were requested to appoint a committee to " visit the town, observe and report upon its general sanitary condition, and whether, in their judgment, for the protection of the public health, it is necessary to adopt a system of sewerage; and that no further action be taken relative to public sewers until such report can be heard by the town."

In August, 1883, in compliance with the request above referred to, a committee of the Board was appointed, consisting of Dr. H. P. Walcott, John Fallon, Dr. E. Hitchcock, Dr. E. E. Dean, and the health officer of the Board, who visited the town during the same month, and conferred with the local committee appointed by the town. The same committee also conferred with the local board of health, and, in company with the town committee, examined the condition of the town with reference to the location of its present sewers and drains and their outlets, the condition of the water supply, the wells in use by the inhabitants, the vaults and cesspools in their immediate neighborhood, and other questions pertaining to the health of the town.

Soon after the return of the committee, several samples of water were obtained from the wells in various parts of the town, and also from the public supply, and were submitted to Prof. Edward S. Wood for analysis.

The report of the committee appointed by the State Board is herewith given, and also the statement of water analysis, together with the report of the engineer, as recommended in the committee's report.

Some doubt having been expressed by the local committee as to the accuracy of the figures compiled from the Registration Reports of the State, the result of the investigation of the local committee, together with their comments thereon, are also given herewith.

Report of Committee on the Sewerage of Nantucket.

A system of public sewerage having been proposed for the town of Nantucket, as a measure of necessity for the public health of its citizens, and the town having consulted the State Board of Health, Lunacy and Charity with reference to the expediency of the proposed plan, a committee of the Board have visited Nantucket in compliance with the expressed wish of the town's committee, and conferred with them, and do hereby respectfully make the following report: —

In order to take an intelligent view of this question, it is important to obtain a correct statement of the health of Nantucket during the past few years of its history, and also an estimate of its present sanitary condition. For this purpose it will be necessary to deal to a considerable extent with statistics, and while it is true that too great reliance cannot be placed in mortality tables when dealing with short periods of time, and with small numbers of people, we believe that a tolerably just estimate may be obtained from the State Registration Reports, tracing the records from as remote periods as the accuracy or extent of the tables will permit.

If we have entered upon this subject with apparent tediousness of detail, we trust that the result will justify the research.

In reviewing the data, we find scarcely any population in the State which presents so peculiar and interesting a history as Nantucket, as the census and registration reports will show.

Population. — In prosperous times, when the whaling interest was at its height, during the decade 1835–1845, the population of the island had reached 9,012 (census of 1840). From that date the decrease was rapid until at the State census of 1875 the actual population of the island was but a little more than one-third of its highest figure (3,201), or considerably less than its population nearly a century earlier (4,620 in 1790). This rapid decrease affected all ages of the people, but mainly the younger and more vigorous portion, whose withdrawal left upon the island an undue proportion of old people. This fact is shown in the average age at death of the population, which in 1845 was 24.95 years, being considerably less than that of the State, which was 33.74 for the same year.

For the seventeen years from 1865 to 1881 inclusive, the average had increased to 52.14 (or more than double that of 1845), while for some years it was as high as 60; that of the State for the same period was but 30.34. A similar result may be shown, though in a diminished ratio, in any place where the population has either diminished or remained nearly stationary for many years, as in Dukes County, whose population in 1790 was 3,232, in 1840, 3,958, and in 1880, 4,300. The average age at death in Dukes County in 1880 was 50.98. This extremely high average age at death cannot be adduced to prove the healthfulness of a population. For, *ceteris paribus*, the average age at death of any community will be determined by the class of the community which is predominant.

The actual ages of the population at Nantucket vary considerably with those of the State. The population by the national census of 1880 is as follows: —

Total, 3,727, of which 1,642 were males and 2,085 females, or 40.06 per cent. and 55.94 per cent., while of the State population 51.85 per cent. were females and 48.15 per cent. males.

This disturbance of the natural equilibrium of the sexes is doubtless due chiefly to the same causes which have affected the whole State in a less degree, — the withdrawal of the younger males by emigration.

The number of children of school age, or as given in the national census (from 5 to 17), presents also a contrast with the State, the ratio of this age being 23.97 for the State, and 18.19 for Nantucket.* Continuing the comparison, the greatest variation is in the next class, or the enrolled males from 18 to 44 inclusive, which class has mainly been affected by emigration. The ratio of this class to the whole in the State is 20.93 per cent. In Nantucket it is but 14.91 per cent.

The next class enumerated by the census of 1880 is that of males of 21 years and over, which necessarily includes nearly all of the last class (18 to 44), together with all the males

	Nantucket.	State.
* Birth-rate for 1880, ...	1.50	2 47
Marriage-rate, ...	.72	.87

who have passed the age of 45. The ratio in this class in Massachusetts is 28.18 per cent.; in Nantucket 30.05 per cent.; thus showing that the middle-aged and the old men are sufficiently in excess to more than counterbalance the deficiency in the younger class. Reference to these figures would be of but little value, if considered alone. They should be considered in connection with the mortality rates.

With the foregoing data in view, we should expect to find among the mortality tables of Nantucket a predominance of those diseases which are common to old age, and *per contra* a deficiency of those which are common to the young. While the former condition necessarily exists, the latter does not exist. For, on consulting the tables of the Registration Reports for the past eleven years, going back as far as the data have been furnished upon this point, we find that certain preventable diseases common to the young are not only predominant, but have so affected the general mortality-rates as to cause them to exceed those of the State itself. For example, typhoid fever is not a disease of old age, but rather of youth and middle life (90 per cent. of deaths occur between 10 and 40 years). In Nantucket, for eleven years ending 1881, there were 29 deaths from this disease, a rate of 7.7 per 1,000 for the given period, the rate for the same disease for Massachusetts for the same period being 6.42. But the ratio of the population of Nantucket between the years 10 and 40 is less than that of the State. Hence we should expect a less instead of a greater fatality.

Diphtheria is still less a disease of old age (90 per cent. of all deaths being under 25 years), and yet Nantucket shows a mortality for eleven years of 70 or 18.77 per 1,000 for that period, while the ratio of the State was 11.85 for the same time.

In the case of dysentery, which is common to all ages, the rate of Nantucket was 4.01 per 1,000, for the period named, and that of the State 2.75 for the same period.

The figures relating to phthisis or consumption are adduced here especially to show that the mortality is not confined to the aged, since phthisis is a disease of the young and middle-aged (75 per cent. of all deaths from phthisis are under 50 years). The mortality from phthisis at Nantucket is excessive, and for the period named was 63.59 per 1,000, while that of the State was 33.65, and that of Dukes County still less (29.06).

The cause of this excessive mortality, and the contrast in this particular with Dukes County, whose population, climate, soil and general topography are so similar, is not easily explained, — possibly the effect of inheritance through a long series of successive generations. There are, however, certain differences between these two communities. The population of Dukes County is more uniformly distributed throughout the island of Martha's Vineyard in several villages, none of which are crowded, except at Cottage City, which is of recent growth, and, having a transient population present but for a few weeks, it does not materially affect the census or the mortality-rates. The population of Nantucket, on the contrary, or at least nine-tenths of it, are quite densely accumulated in one town of a small area, having many narrow streets, with small house-lots, necessitating a dangerous proximity of cesspools, privy-vaults and wells.

This population of less than 4,000, is also burdened with the contaminating influence of the old and loosely-constructed cesspools and vaults of a former generation of more than 9,000, and notwithstanding the care alleged to be used in regard to these receptacles, the foul odors emanating from them are too noticeable to escape detection in the public streets of the town.

The soil of Nantucket is entirely of an alluvial formation, sand or gravel predominating, a soil unusually favorable to rapid percolation, and so long as wells are largely used for domestic purposes this character of the soil constitutes an element of danger. The climate of Nantucket is more equable than that of any other part of the State, and is naturally attractive to the health-seeker. Its mean annual temperature is 50° Fahrenheit. Its mean summer temperature is 67½°. Its mean winter temperature is 33°.

The mean of the four months June, July, August and September, as given by a careful observer, for one year, was 63 6, 71., 68.9 and 63.4. The mean winter temperature is seven degrees warmer than that of Cambridge. The insular position of the town and the sensible proximity of the Gulf Stream lend their combined influence to modify the extremes of temperature, such as exist elsewhere in the inland parts of the State. The summer temperature of the water upon its shores renders sea-bathing recreative, invigorating and pleasurable, even to the delicate invalid. Dr. Lincoln found the temperature of the water varying from 67° to 77° in July, 1875, at different points upon the shore. He states: "The great value of the bathing consists in the mildness of both water and air, which permits delicate persons to enter the water without a shock, and in leaving it, to regain quickly their normal circulation. Except on rainy days, which are rare, one is sure to have a brilliant sun; fogs and clouds seldom interfere with the effects of the insolation. In my opinion these qualities of the bathing are of very great importance." *

Add to these facts its constant exposure to the healthful play of

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* Boston Medical and Surgical Journal, Oct. 7, 1875.

sea-breezes from every quarter, and one would naturally expect to find among its inhabitants a lessened rather than an increased mortality-rate. A slight progressive decrease is noticeable in the death-rate of the population since 1878, and although the period is short and the population comparatively small, may we not attribute a certain improvement to the introduction of an uncontaminated water supply?

It must be admitted, as already stated, that too great reliance cannot be placed upon statistics when applied to small numbers of people and to short periods of time. Nor can the inflexible rules of mathematics be employed to determine with certainty the future sanitary condition of a given population. But when, as already shown, the mortality-rate of a county has for seventeen years exceeded that of the State, with the exception of two years, and for nineteen years, with one exception, has largely exceeded that of a neighboring county, whose conditions as to climate and population are very similar, the fact cannot be regarded as simply accidental. The advice of one of the most celebrated of modern sanitarians is worthy of quotation here: —

> "My practical advice remains substantially what it has been for years. The local conditions of safety are, above all, these two:
>
> 1. That, by appropriate structural works, all the excremental product of the population shall be so promptly and so thoroughly removed, that the inhabited place, in its air and soil, shall be absolutely without fecal impurities.
>
> 2. That the water supply of the population shall be derived from such sources and conveyed through such channels that its contamination by excrement is impossible." — *John Simon.**

As to the actual advantage derived by following this advice, reference is made to the results obtained in twenty-five English towns, following the introduction of public works of a sanitary nature. In nearly all of these, there was not only a material reduction in the general mortality-rate, but also a decided reduction in the mortality from typhoid fever and phthisis.

The introduction of public sewers is a matter of necessity as important as that of the introduction of pure water, and in the case of Nantucket, with its loose, sandy soil, its compact population, its narrow streets and lanes, its increasing summer population, the introduction of large hotels and boarding-houses, and the consequent increase of sewage attending them, a system of sewers is a matter that must be initiated sooner or later. The present sewers are evidently inefficient, improperly constructed and devoid of any general plan, their outlets being a public nuisance.

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* Ninth Report of Privy Council on Public Health, London, 1867, p. 34; also Massachusetts State Board of Health Report, 6th volume, 1875, pp. 72, 73.

It is therefore the opinion of the committee that a competent engineer should be employed by the town, who shall survey the same, with reference to a system of sewerage, the question of a gradual introduction in successive years, or an immediate plan, to be determined by the town as may be deemed expedient. In expressing this opinion we would by no means convey the impression that the introduction of public sewers appears to be the absolute and only mode of relief, as a sanitary measure. So radical a change may not be practicable at present for every street and lane of the town. The portions which most need the remedy already suggested are the main street and the adjacent streets, especially those upon which hotels and boarding-houses are situated.

As a further measure of protection to the public health, the control of the present water-shed of the public water supply is a matter of importance, and its use for domestic purposes should be so restricted as to guard the pond from pollution, since a small pond without a natural outlet or inlet, however pure its water may be, becomes proportionately more dangerous under conditions liable to contaminate, than a larger source with a constant overflow. With such precautions the abandonment of private wells is desirable, except such as are at a reasonably safe distance from any polluting source.

NOTE. — It should be observed that epidemics are always liable to affect mortality-rates unfavorably, especially in the case of small numbers of population and brief periods of time. Such was the case at Nantucket in the five years (1876–1880) inclusive, during which time there were 62 deaths reported from diphtheria, and only 3 in Dukes County. Such a result might happen to any similar community. Its significance, however, is materially enhanced, when the data are grouped with those of other infectious diseases.

Mortality Rates of Nantucket and Dukes Counties, and of the State, from 1853 to 1881 inclusive (Twenty-nine Years).

1853 TO	NANTUCKET.	DUKES COUNTY.	STATE.
1862, ...	16.45	19.70	17.80
1863, ...	15.76	15.68	22.45
1864, ...	20.02	16 35	23.33
1865, ...	28.01	15.48	20.64
1866, ...	18.90	15.20	18.10
1867, ...	17.90	13.60	17.00
1868, ...	16.40	16.20	18.60
1869, ...	21.30	11.70	18.40
1870, ...	22.50	18.50	18.70
1871, ...	22.80	17.20	18.70
1872, ...	20.40	22.70	22.80
1873, ...	25.70	15.30	21.60
1874, ...	27.20	21.90	19.80
1875, ...	26.20	17.20	21.20
1876, ...	32.80	16.20	19.60
1877, ...	49.90	18.20	18.00
1878, ...	34.70	19.80	18.50
1879, ...	33.10	16.70	19.30
1880, ...	30.86	13.95	19.79
1881, ...	30.10	22.30	20.40

Average Death Rate (Twenty-nine Years), 1853-1881.—Nantucket, 22.72; Dukes County, 17.97; State, 19.13.

Average Age at Death, 1845. — Nantucket, 24.95; State, 33.74. Average age at death for 17 years, from 1865 to 1881: Nantucket, 52 14; State, 30.34.

Mortality from certain specified Diseases in Nantucket, Dukes County, Boston, and the State of Massachusetts for Eleven Years — 1871 to 1881 inclusive.

	POPULATION IN 1880.	TYPHOID FEVER.		DIPHTHERIA.	
		No. Deaths.	Rate per 1,000.	No. Deaths.	Rate per 1,000.
Nantucket, . .	3,727	29	7.70	70	18.77
Dukes County, . .	4,300	37	8.59	7	1.62
Boston, . . .	362,839	2,047	5.64	4,866	13.41
Massachusetts, . .	1,783,085	11,448	6 42	21,137	11.85

Mortality from certain specified Diseases, etc., — Concluded.

	Population in 1880.	Dysentery.		Phthisis.	
		No. Deaths.	Rate per 1,000.	No. Deaths.	Rate per 1,000.
Nantucket, . .	3,727	15	4.01	237	63 59
Dukes County, . .	4,300	8	1.85	125	29.06
Boston, . . .	362,839	986	2.71	13,073	36.02
Massachusetts, . .	1,783,085	4,930	2.75	60,187	33.65

Ages of Persons living in Nantucket from 1861 to 1883 inclusive, with Rates per 1,000 of the Population.

Ages in periods of five years.	Rates per 1,000.	
	Nantucket.	State.
61 to 65, ...	59.59	25.25
66 " 70, ...	53.66	20.05
71 " 75, ...	54.20	13.04
76 " 80, ...	27 90	8.49
81 " 85, ...	12.34	3 77
86 " 90, ...	.62	1.47

The following data were compiled at the request of the local committee by Capt. George C. Allen, from the town clerk's record of deaths for the years embraced in the preceding report. The explanation given by the local committee relative to the discrepancy in the two tables is, that "those who died in other places, and were taken to Nantucket for burial, were included in the town clerk's returns to the Secretary of the Commonwealth as having died in Nantucket."

Mortality from certain specific Diseases in Nantucket, Dukes County, Boston, and the State of Massachusetts for Eleven Years, 1871 to 1881 inclusive.

	Population, 1880.	Typhoid Fever.		Diphtheria.		Dysentery.	
		No. Deaths.	Rate per 1,000.	No. Deaths.	Rate per 1,000.	No. Deaths.	Rate per 1,000.
Nantucket, .	3,727	29	7.70	70	18.77	15	4.01
Dukes County,	4,300	37	8 59	7	1.62	8	1.85
Boston, . .	362,839	2,047	5.64	4,866	13.41	986	2.71
Massachusetts,	1,783,085	11,448	6.42	21,137	11.85	4,930	2.75

Capt. Allen's.

Nantucket, .	3,727	9	2.44	49	10.46	12	3.22

Typhoid Pneumonia, 3 died.

"In comparing the two statements, you will see the difference is most marked in the death rate from typhoid fever, being 5.26 per 1,000. As shown by the latter statement, the actual death rate from that disease in Nantucket is lower than any of the places referred to excepting Dukes County. From diphtheria it is below the average of the State, but from dysentery it is larger than that of the State or either of the places above referred to. The committee refer more particularly to this matter, as it is an important factor to be taken into consideration in determining whether the construction of sewers is necessary for the preservation of the health of our people; typhoid fever, diphtheria and dysentery are designated filth diseases, occasioned largely from defective sanitary conditions.

Should the town decide to adopt a system of general sewerage, in order to provide means therefor, we recommend issuing bonds bearing interest at the rate of 4 per cent. per annum, payable in twenty years; that the annual interest and contributions to a sinking fund be raised by general taxation; that one-eighth part of the cost of constructing, maintaining and repairing said main sewers shall be assessed upon the estates on the streets or ways where sewers are constructed, and in accordance with the provisions of sect. 7, chap. 50 of the Public Statutes, the balance to be paid by general taxation."—*Extract from Report of Town Committee, Jan. 22, 1884.*

CAPT. ALLEN'S STATEMENT.

Mortality from certain specified diseases in Nantucket, taken from the town clerk's record, for eleven years — 1871 to 1881 inclusive. Population, 3,727. Number of deaths from typhoid fever, 9; rate per 1,000, 2.44. Number of deaths from diphtheria, 49; rate per 1,000, 10.46. Number of deaths from dysentery, 12; rate per 1,000, 3.22. Number of deaths from consumption, 177; rate per 1,000, 40.28. Number of deaths from typhoid pneumonia, 3. I have examined the town clerk's report carefully, and find the above result.

GEORGE C. ALLEN.

NANTUCKET, Dec. 14, 1883.

I also find from the record in the above years there were a number of deaths in other places of natives of the island, that were brought here for interment, as follows: Typhoid fever, 17; diphtheria, 9; consumption, 73; dysentery, 1.

George C. Allen.

State Board of Health, Lunacy, and Charity,
Department of Health,
State House, Boston, December 5, 1883.

T. C. Defriez, Esq., *Secretary*.

Dear Sir, — I have received your letter of Dec. 3 with information as to the Nantucket waters, and in return I enclose the report of Dr. E. S. Wood, giving the analysis of the same. I have made a copy of the analysis and send you the original. Please to note the superiority of Nos. 12 and 13 in many points to the other numbers on the list.

Respectfully yours,

S. W. Abbott, *Health Officer*.

Water Analysis.

Parts in 100,000.

No.	Locality, Nantucket, Mass.	Date of		Unfiltered.		Chlorine.	Residue.			Hardness.
		Coll.	Anal.	Amo.	Alb. Amo.		Fixed.	Volatile.	Total.	
1	Well Water, .	Oct.	–	.0064	.0296	7.60	28 25	17 75	46.00	15°
2	" " .	"	–	.0088	.0648	3.90	15.00	33.00	48 00	4°
3	" " .	"	–	.0058	.0128	5.40	22.50	15 00	37 50	8½°
4	" " .	"	–	.0054	.0148	5.80	27.00	18.50	45.50	11°
5	" " .	"	–	.0072	.0178	3.90	14.50	20.00	34 50	7°
6	" " .	"	–	.0064	.0110	5.20	13.00	13.50	26.50	6°
7	" " .	"	–	.0024	.0094	4.60	24.00	26.00	50.00	11½°
8	" " .	"	–	.0128	.0244	13 40	53.00	20.50	73.50	13½°
9	" " .	"	–	.0048	.0236	8.60	37.50	15.00	52.50	11½°
10	" " .	"	–	.0009	.0092	6.80	20.00	14.00	37.00	9°
11	" " .	"	–	.0112	.0128	9.60	42.50	16.00	58.50	12½°
12	Wannac't Water,	"	–	.0102	.0210	2 90	4.50	2 50	7.00	1°
13	" " .	"	–	.0074	.0184	3.00	4.50	4 00	8.50	½°
		"								

Commonwealth of Massachusetts,
State Board of Health, Lunacy, and Charity,
Department of Health,
State House, Boston, January 25, 1884.

Dear Sir :— I have received your letter acknowledging the receipt of analysis of waters which you had forwarded to us for examination, and also requesting a definite statement as to the purity or impurity of each sample as indicated by the analysis.

It should be understood that a definite opinion cannot usually be given upon the results of chemical analysis alone, although such analyses are made with the greatest accuracy and care. Experience teaches that we must proceed further before drawing conclusions with anything like mathematical precision. It is desirable also to take into consideration every condition which can possibly affect each particular well, or other source of water supply, before pronouncing an opinion as to its fitness or unfitness for domestic use. It was for this reason that the particulars relating to each sample were requested, none of which have been known by the analyst.

From the analyses of the samples submitted to us, and also the data afterward sent, relating to location and surroundings of wells, it may be inferred that the public water supply of Nantucket, as shown in samples 12 and 13, is of a sufficiently pure quality for domestic use. On the other hand, the waters of the eleven wells (samples 1 to 11 inclusive), show a degree of pollution which should condemn a portion of them as unfit for domestic use. Samples 8, 9, and 11 are evidently bad waters; Nos. 6, 5, and 10, so far as the data furnished show, might be pronounced as reasonably safe, while the remainder are doubtful or suspicious waters.

I have conferred with other members of your committee during the past month, relative to this matter, and have explained it to them, so that further notice at this time may be unnecessary. Another letter was also received from you by the State Board, of the same date as your letter to me, and in behalf of the Board I beg leave to reply.

The letter referred to enclosed a paper containing certain statistics, compiled by Mr. George C. Allen from the town clerk's records at Nantucket, in which it is shown that a certain number of persons, who died of specified diseases, did not die at Nantucket, but were brought there from other places for burial. In the matter of vital statistics, you will please to bear in mind, as has already been stated in the report made to you last year, that the opinion of the Board as to the sanitary condition of Nantucket is not formed from statistics alone, for it is specially true of statistics based upon a small number of inhabitants, that they have a greater range of probable error than in large populations. Other data were taken into consideration, such as the actual sanitary condition of the town at the time of the visit of the committee of the Board, the defective condition of its drainage, the analyses of the water of its wells, and the customs of the inhabitants as to the storage of filth in vaults and cesspools.

With reference to the subject of burials of persons brought from other places, it is reasonable to assume that a considerable portion of this number may have died while away on brief visits, their disease having been contracted at home. Especially in the case of consumption may this be urged, that being a disease of long continuance, in which inheritance, as well as local causes, are acknowledged to be important factors. It must be more than a mere matter of probability that such cases were contracted upon the island, or at least from Nantucket parentage. Especially does this appear probable, since Mr. Allen states, in his extract from the records, that the persons brought to Nantucket for burial were "natives of the island."

Furthermore, the practice of conveying the bodies of persons from a distance to their native towns for burial cannot be regarded as the peculiar characteristic of Nantucket, to the exclusion of other towns, and if it is urged in favor of a lessened mortality of the island population, the same reasoning may be applied to every other community in the State.

Again, if the data which you have presented shall be admitted, may we not on the other hand as reasonably inquire how many people, in the same period, have died in other places, whose deaths were never recorded in Nantucket, but whose illness was contracted there, while they were visiting the island either for business or recreation, a question which is also applicable to any locality.

Permit me, in closing, to express the sincere interest of the Board in the welfare of the island town, and their earnest desire that its future prosperity may be assured.

Respectfully yours,

Samuel W. Abbott,
Health Officer State Board of H., L., and C.

T. C. Defriez, *Sec'y*, Nantucket, Mass.

In compliance with the recommendation of the committee of the State Board, the town employed an engineer to go over the ground, make such observations with reference to its needs as should be necessary, and report to the town committee. The following is the engineer's report: —

ENGINEER'S REPORT.

To JOSEPH MITCHELL, THADDEUS C. DEFRIEZ, JOHN A. BEEBE, JOSEPH S. BARNEY *and* WILLIAM W. McINTOSH, *Committee:*

GENTLEMEN, — In discussing the question of drainage, the principles of combined and separate sewerage should be considered. By combined sewerage is meant that a certain proportion of the rainfall is to be carried in the sewers, in addition to the house wastes, for purposes of flushing, and in order to relieve the surface of streets from floods that might wash the roadways.

Separate sewerage, on the contrary, consists of pipes or ducts, for conveying sewage only, excluding all rain water. Many towns are so situated that the surface water from showers is apt to prove troublesome, and it is cheaper and better in such cases to provide for carrying portions of it in underground channels, rather than wholly in surface gutters. Nantucket, however, scarcely seems to come under this head. There appears to have been no serious difficulty up to the present time in taking care of surface water, and running it off at various points, and there seems to be no more likelihood of it in the future than in the past; moreover, the largely increased size, that would be necessary to provide sufficient carrying capacity for any perceptible portion of the surface water, would render the first cost very great — probably too great to be seriously considered.

The writer advises the adoption of a comprehensive system of pipe sewers calculated on the separate plan, which may be built from time to time, in accordance with the growing necessities of the locality, this system to be figured for the present size and probable growth of the town, the outfall and a few laterals to be constructed at once, and supplemented by local board of health work — the latter more particularly in those portions of the town thickly settled, where the subsoil is clay and where public water is not used.

The only question of really serious moment would appear to be the proper location for the outfall for the main sewer or sewers.

There seem to be three feasible schemes for disposing of the sewage: —

1st. By irrigation, on land to the north and west of the village. The general outline of this plan would be the collection of the sewage in a tight tank; from there pumping, either by wind or steam engine, through an iron force main, and delivering onto some of the porous sandy loam between the village and the water works; the land thus irrigated to be used as a market garden, in that way reducing the cost of maintenance very considerably. Of course the cost of pumping would be a constantly increasing one, as the sewer system was extended, and at the best something of a burden. At the same time the measure of cost should at all times be appreciably less than the cost of the pumping station of the water works, even if steam be used (in spite of the length of force main for the sewage and great friction), for the quantity to be moved and the requisite power would both be less.

2d. Running the sewage by gravity to the north side of the jetty and allowing it to run to waste at that point, at low water.

3d. Discharging the several sewers into the harbor at various points, or collecting at one point and filtering before allowing the the sewage to debouch into the harbor.

Of the three schemes, the first is undoubtedly the best on every account save that of expense. There should never be annoyance or trouble, and for years periodical pumping should amply suffice.

In the second plan the fall would be so slight (perhaps 5 feet in 4,000), that the main sewer would have to be constructed quite large and delivery would only be at low water — virtually the sewage would be "ponded" for many hours each day and have a tendency to deposit sediment at various points. Superficial examination at the proposed outfall, raises the question also whether the shifting sands might occasionally cause trouble by silting up the outlet.

The third plan converts the harbor into a cesspool, which of course never could be emptied. If filtering was adopted, the sewage would be much clarified, and the objection to running the effluent water into the harbor considerably lessened, though it would still prove a decided objection. In order to filter, power would be necessary to get the requisite head, and it may be an open question whether, if pumping is to be resorted to at all, it would not be wiser to pump the additional 60 feet elevation necessary to reach the back land, as outlined in scheme 1, rather than to attempt filtering at a slightly reduced cost — a process which, at best, is something of an experiment.

If the public water was generally introduced throughout the town and the use of wells forbidden, save where they were proved to be sound and good, and were tested periodically to ensure their remaining so, the building of many of the lateral sewers might be delayed for years to come. In point of fact, if this could be accomplished, it would prove the least expensive arrangement, and should be reasonably satisfactory from a health point of view.

It will be seen at once that the requisite sizes for the sewers, both mains and laterals, will depend solely upon the areas to be drained and the grade of the pipes. At present there are no data for calculations of this character, and until levels are obtained which will show the relative grades of buildings and streets, together with all the inequalities of the surface, such calculations are not possible.

The surveys of the water company, although doubtless accurate as far as they go and sufficiently ample for water supply purposes, are entirely inadequate for sewerage, except as a nucleus, and the other plans in existence vary to the extent of several hundred feet in both directions, so that they could not be relied upon. Suitable and comprehensive surveys would cost fully $500, possibly more, but they should be made before any actual constructive work be started.

So far as can be judged now, the sewer system, when finished, would be some eleven miles in length, although, with care, it seems possible to reduce this so that a maximum length of not over seven miles would answer for a number of years to come, and possibly one-third or one-half this amount would be sufficient for the needs of the immediate future. This, of course, omits all house connections.

Referring once more to the question of cost and judging solely from similar work done at other places, seven miles of pipe sewers might cost between thirty and forty thousand dollars.

The materials advised would be Akron and Columbus vitrified pipe, "American Rosendale" cement, tested to the "Improved Sewerage" standard, hard-burned Eastern brick and cast-iron. The prices for pipe and cement should be no higher than Boston figures; brick and iron somewhat more.

ERNEST W. BOWDITCH, *Engineer.*

60 DEVONSHIRE STREET, BOSTON, Dec. 5, 1883.

NOTE.—The plan referred to in this report will be presented at the annual town meeting.

This report was submitted to the action of the town meeting held in the following February, and its recommendations were favorably considered. But at a subsequent meeting the favorable action of the town was reconsidered, and since that time no action has been taken.

The condition of affairs at Nantucket is somewhat similar to that existing at Cottage City, as described in the First Report of this Board (Supplement to Public Health, 1879), with this exception, that the latter place is of recent growth and its chief population is present through a few months only of each year. So far as the results of chemical analysis may be taken in proof of water pollution, the pollution of well-water at Nantucket, as shown in the present report, would appear to be much greater than that existing at Cottage City.*

This condition may reasonably be considered as due to the more damaging effect of long-continued pollution, the soil in the two localities being quite similar in character.

The old style of privy, with shallow excavation, or with a vault loosely constructed to admit of percolation of the fluid contents, and also of cesspools constructed on a similar plan, appears to be the rule at Nantucket, and since the introduction of a public water supply the conversion of abandoned wells into cesspools has not been an uncommon practice.

With the certainty of pollution of the surrounding soil, and the difficulty of removal of their contents, such a practice cannot be too strongly condemned.

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* Supplement on Public Health, 1879, First Annual Report of State Board of Health, Lunacy and Charity, pp. 170, 171.

ARSENIC AS A DOMESTIC POISON.

By Prof. Edward S. Wood, M. D.

ARSENIC AS A DOMESTIC POISON.

BY PROF. EDWARD S. WOOD, M. D.

Since the publication, in January, 1872, in the report of the Massachusetts State Board of Health of the (at that time) exhaustive article by Dr. F. W. Draper, of Boston, "On the Evil Effects of the Use of Arsenic in certain Green Colors" (Public Document, No. 31, January, 1872), the advance in our knowledge in regard to the use of arsenic in articles of domestic use, and of its effects upon people using such poisoned substances, has been so great, that it seems desirable to again call the attention of the public to this subject, especially since it has thus far been impossible to obtain legislation in this country for the prevention of the manufacture and sale of such poisonous articles.

It will be the object of the following paper: (1), to show how very extensive is the employment of arsenic in the manufacture of articles intended for domestic use; (2), to show in what form the arsenic is used, since in many instances the introduction of this poison is accidental, as, for example, due to the use of some substance supposed to be pure and non-arsenical, which is really contaminated with arsenic; (3), to prove indisputably by the citation of well-authenticated cases, that arsenic, when used in the manufacture of domestic fabrics, such as wall-papers and clothing, may, and frequently does, give rise to very unpleasant symptoms, and sometimes to dangerous and even fatal poisoning, and that, when so employed, it is very deleterious to the public health; and (4), to mention the measures which have been adopted in other countries for the diminution of this evil, which is so great in this country.

Sources.—Of the various sources of domestic arsenical poisoning, the following may be mentioned as the principal ones : —

Wall-papers and other papers, the most dangerous of which are the glazed papers used for wrapping confectionery, such as lozenges ; for the use of children in kindergarten schools ; for theatre and concert tickets ; for the manufacture of playing cards ; for covering paper boxes, these boxes often being used for containing confectionery ; clothing and other textile fabrics, such as cretonnes for covering furniture, for lambrequins ; and even linen glaze has been found to contain arsenic ; artificial flowers and leaves, which are sometimes worn in contact with the skin, in which case they are sure to produce a troublesome eruption ; children's toys are frequently colored with arsenical pigments ; articles of food or drink may sometimes contain arsenic in small amount, such as confectionery colored with arsenical fuchsine or arsenite of copper, or red wines and syrups artificially colored with an arsenical red pigment. Other sources of domestic arsenical poisoning, which are, however, more liable to give rise to acute than to chronic poisoning, owing to the accidental ingestion of large doses, are Paris green or arsenite of copper ; London purple, which is a highly arsenical refuse from the manufacture of certain aniline dyes ; "rough on rats," German fly-paper, and the "Buffalo carpet-moth annihilator," — all of which substances contain a very large amount of arsenic, and are frequently seen in the household, especially in the country, the two first being used for killing potato bugs, and the three last for destroying house pests. The German fly-paper is simply a coarse bibulous paper soaked in a strong solution of arsenite of sodium, and subsequently dried.

By far the most common source of domestic arsenical poisoning is wall-paper, which frequently contains an enormous amount of arsenic in the coloring matter. It was formerly supposed that the green papers were the only ones which were arsenical, but at the present time we find arsenic more frequently in wall-paper of other colors than green. This is probably due to the fact that the public has been more frequently informed in regard to the arsenical nature of the green papers and pigments, and hence people are more liable to suspect the poisonous character of papers of this color, and to inquire of the dealer as to whether they are arsenical or not, than with regard to other colors. The green pigments most frequently used nowadays are mixtures of non-arsenical blue and yellow pigments, such as Prussian blue and chrome yellow. We find the red and blue papers to be arsenical more frequently than the green. In fact, papers of any color and of any shade may be arsenical; so that there is absolutely nothing in the appearance of a paper by which we can form any opinion as to its arsenical or non-arsenical nature. We have also found, in a few instances, that, of different rolls of what appears to be the same paper, the pattern and the shades of color being precisely the same, so far as could be seen, one roll contains arsenic, while another does not. This is readily explained by the fact that the pigments used in the manufacture of the two rolls, came from different lots, one being pure and the other arsenical, the color produced by the two lots of pigment being identical. We have also known of arsenic being found in the white ground-work of a paper intended for the walls of a nursery; in this case, it is probable that the arsenic existed in the paste or size with which the pigment was made to adhere to the paper, the arsenic having been added to the paste to prevent it from undergoing decomposition, and becoming sour and offensive to the sense of smell. But, even when used in this way, it is just as dangerous as when it is a constituent of the pigment itself, since it can be detached with the white pigment in the form of dust, or in a moist atmosphere may give rise to the formation of arseniuretted hydrogen, as readily as when in the form of Scheele's green or Paris green.

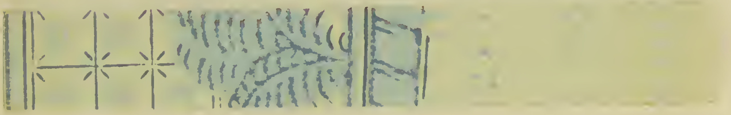
It is unnecessary to describe the method of manufacture of wall-paper, since that has been already done by Dr. Draper in the article alluded to above, and he has there shown in what manner workmen in the paper manufactories come in contact with the poisonous pigments and become affected by them.

Of a large number of specimens which have been examined, the accompanying have been selected as illustrating the principal points which have been mentioned above. It will be seen by an examination of these, that one color is as liable to be arsenical as another, and also that the price of the paper affords no security against its poisonous nature, since some of the very expensive papers contain a very large amount of arsenic, while some very cheap papers contain none. In the case of all of these papers the amount taken for analysis was about one-half of a square foot, and no attempt has been made in those specimens which contain different colors to ascertain which color contains the arsenic. The writer has never detected arsenic in the plain, so-called "cartridge," papers, although he has examined a great many specimens. It will also be noticed that the specimen containing a brilliant green pigment (No. 24) is non-arsenical, showing that arsenic is not at all necessary in the manufacture of papers of this color.

No specimens of papers, in which almost pure Scheele's or Paris green constitutes the pigment, have been included in the following list, since, although they, as a rule, contain a very much larger amount of arsenic than those shown below, they have been spoken of in detail in Dr. Draper's article referred to above, and also because the handling of such highly arsenical papers in binding them in the report gives rise to extremely disagreeable effects. The specimens exhibited in Dr. Draper's report, for instance, contained respectively, 78., 48.78, and 263.88 grains in each square yard of paper, and the binders were more or less affected by handling them.

No. 1.

No. 2.



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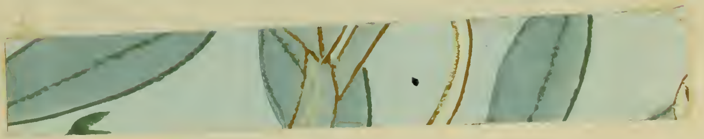
No. 4.

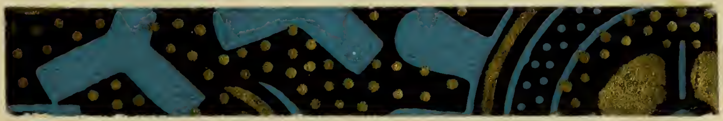


No. 5.

No. 6.

No. 7.

No. 8.



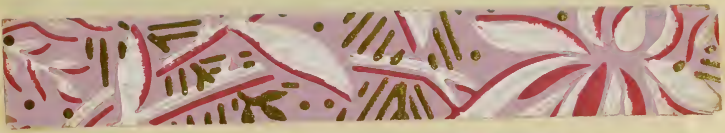
No. 9.

No. 10.

No. 11.

No. 12.

No. 13.



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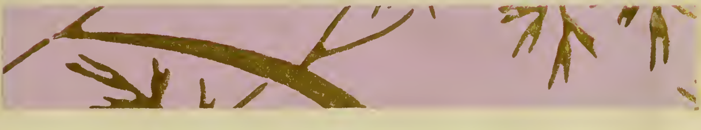

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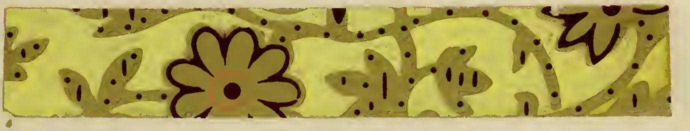

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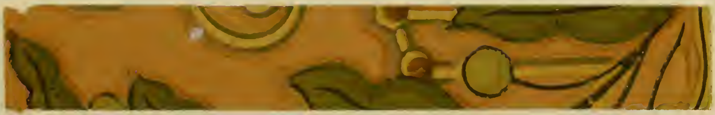
No. 17.



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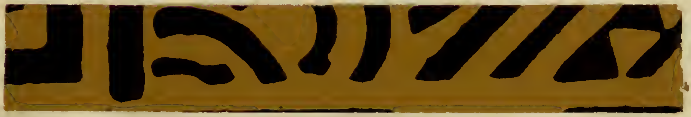

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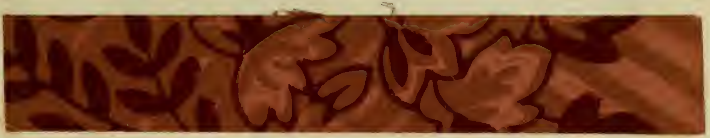

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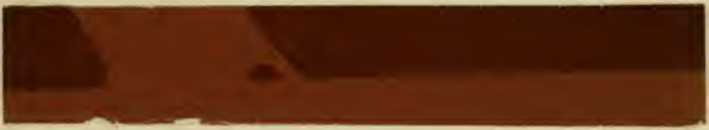

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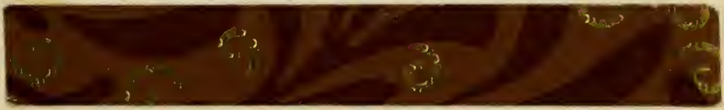

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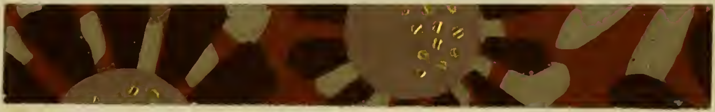

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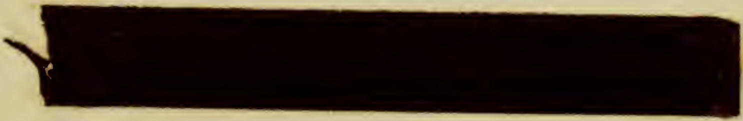

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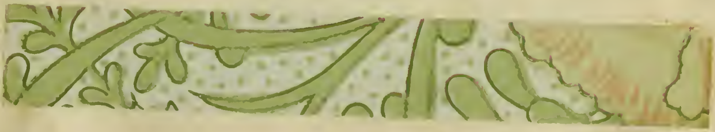

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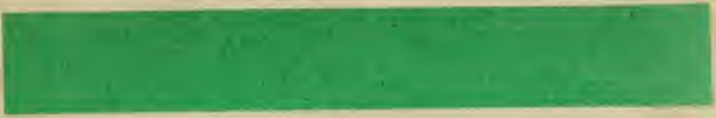

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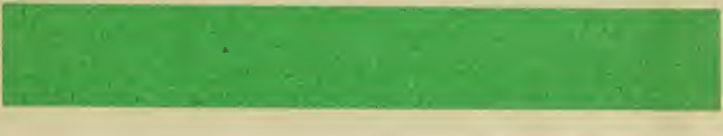

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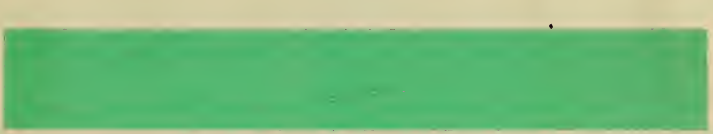

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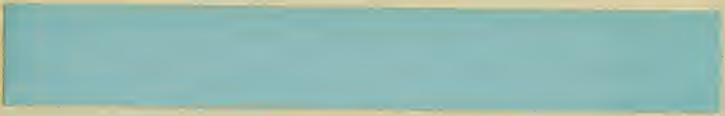

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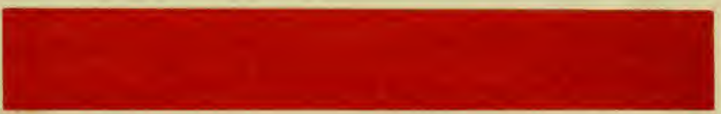

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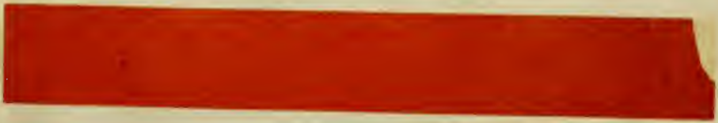

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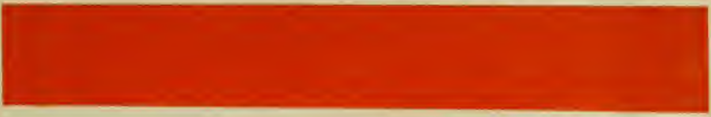

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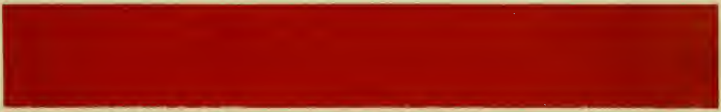

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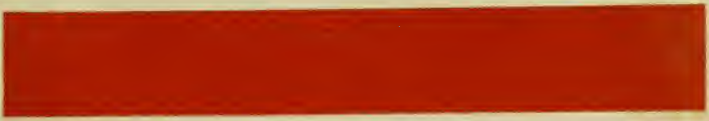

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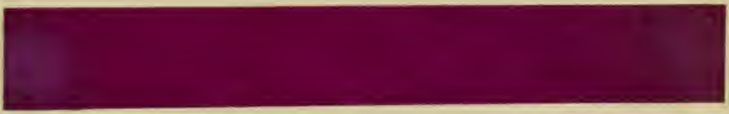

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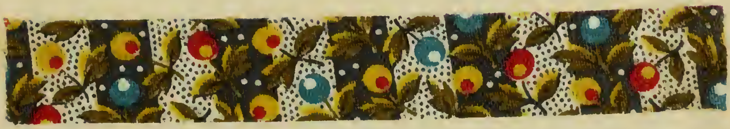

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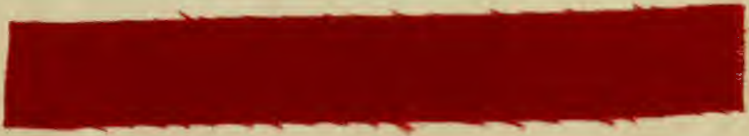

No.	Price per Roll.	Milligrams per Square Meter.	Grains per Square Yard.	
1	$0 75	98 2	1.25	Nursery paper.
2	75	98.2	1.25	" "
3	60	130.7	1.67	
4	75	98.2	1.25	
5	75	523.2	6 74	
6	1 50	490.5	6.27	
7	50	163.4	2.09	
8	60	65.5	.84	
9	3 00	130 7	1.67	
10	60	46.4	.59	
11	75	196.	2 50	
12	1 50	228.8	2.93	
13	60	65.5	.84	
14	60	65.5	.84	
15	35	196.	2.50	
16	50	98.	1.25	
17	35	196.	2.50	
18	50	130.7	1.67	
19	20	294.	3.76	
20	1 75	196.	2.50	
21	2 00	425.	5.48	
22	2 00	278.	3.58	
23	–	309.8	3.99	
24	20	00.0	0.00	
25	–	*1760.	*22.65	Glaz'd & plat'd pap'rs
26	–	*4341.	*55.88	" " "
27	–	*3162.	*40.7	" " "
28	–	Consider'ble	amount.	" " "
29	–	Large	amount.	" " "
30	–	Large	amount.	" " "
31	–	*690.	*8.89	" " "
32	–	Large	amount.	" " "
33	–	Large	amount.	" " "
34	–	*96.	*1.24	" " "
35	–	81.7	1.05	Calico.
36	–	98.	1.25	Turkey-red Cotton.

Of other papers, the most dangerous are the glazed and unglazed papers, called in the trade "glazed and plated" papers, so largely used by children in kindergarten schools, where the papers are handled daily by the children. Some of these papers contain a large amount of arsenic. Of six specimens analyzed by Dr. C. Harrington in the laboratory of the Harvard Medical School, one of the reds (un-

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* These figures were obtained from analyses of "glazed and plated" papers of a different lot, but of the same color and shade, by Dr. C. Harrington.

glazed) was found to contain about one grain of white arsenic to the square foot (0.690 grm. per square meter), another red (glazed) about one-sixth of a grain to the square foot (0.096 grm. per square meter), one of the greens (glazed) about seven and one-fourth grains to the square foot (4.341 grm. per square meter), another green (glazed) about three grains to the square foot (1.76 grm. per square meter), an unglazed green about five and one-fourth grains to the square foot (3.162 grm. per square meter), and a second unglazed green about three and one-fourth grains to the square foot (2.626 grm. per square meter). These figures show how extremely dangerous such papers may be, especially when given to those children to play with who habitually carry everything to their mouths, as many children do. The teacher may, to a certain extent, prevent accidents by cautioning the children about putting any of the colored papers in the mouth, — many kindergarten teachers do take this precaution, — but the pretty, vari-colored ornaments made from them are frequently carried home, and are there liable to get into the hands of, and be sucked by, younger children and infants. It will be noticed that one of the above papers contains, in one square foot, double the fatal dose of arsenic for an adult. The surprising feature of the extensive use of these papers by children is, that numerous accidents have not occurred and been recorded. This may explain, however, many cases of irritable stomach and indigestion, which have been ascribed to taking cold, or to some indiscretion in diet. The teachers themselves may suffer the ordinary symptoms of wall-paper poisoning from habitually handling these highly arsenical papers. The symptoms would be the same as those produced by wall-paper in paper-hangers, and in those inhabiting rooms papered with arsenical paper.

The same remarks are applicable to the use of similar papers for covering paper boxes, especially when such boxes are intended for containing articles of food like confectionery, since any moist article of food, when placed upon the outer surface of the cover or box, as is liable, will absorb a larger or smaller amount of the poisonous color, according as it is in contact with it for a longer or shorter time. This fact has been shown repeatedly, as in the case quoted by Dr.

Draper, in which a child narrowly escaped death by eating chocolate, about which was wrapped a piece of arsenical green paper (*vide* Mass. State Board of Health Report, Jan., 1872, page 31), and in a case in which prunes absorbed a sufficient amount of arsenic from a grocer's arsenical price-card to produce vomiting, which lasted for several hours. (Ibid., page 32.)

Similar colored papers are largely used, even at the present time, for wrapping confectionery, especially the green paper habitually used for sassafras lozenges, and the dark-red or magenta-colored paper for checkerberry lozenges being highly arsenical. Every one knows how liable young children are to get some of the paper into the mouth. In such cases the indigestion resulting from this would, however, unless very serious, be ascribed rather to the candy which the child had eaten, than to the arsenic from the paper wrapper. The fact should never be lost sight of, that wrapping paper of other colors than green is apt to be arsenical, especially the reds, browns and blues.

Similar papers are also used in the manufacture of theatre and concert tickets, playing cards, and everything else which is made from cardboard. Dr. Stevenson Macadam, in a paper read at the meeting of the North British Branch of the Pharmaceutical Society, Jan. 22, 1880, calls attention to the prevalence of arsenical pigments in many common things, and gives the result of analyses of three papers used for covering boxes, making tickets, etc. One contained to the square foot of paper 45.4 grains of arsenic, another 35.98 grains, and a third 16.22 grains, making an average of 32.53 grains; so that a small-sized bandbox, having about three square feet of surface, would contain about 100 grains of arsenic.

The presence of arsenic in children's toys, and the dangers resulting therefrom, have been treated of by Dr. Draper in the article alluded to above (page 28), but arsenical greens are there the principal colors referred to, while it should be remembered that, as in the case of paper, other colors are also liable to contain arsenic. The following toys have been found to contain arsenical pigments: toy paints, building blocks, India-rubber balloons and painted balls, painted India-rubber dolls, children's books (both paper and cloth sometimes containing arsenic), and toy candles.

The writer recently bought a box of small toy candles, such as are used in ornamenting Christmas-trees. The box contained fifty small candles, of which fourteen were bright green, the coloring matter being arsenite of copper, and in very large amount. One of these candles, weighing 5.6415 grams (86.9 grains), contained 0.046 grams (0.7 grains) of white arsenic, or 0.8 per cent. This is a very dangerous arsenical substance, since, in burning, white arsenic is one of the products of combustion, and is necessarily disseminated throughout the air of the room in the form of an impalpable, invisible dust.

Articles of Clothing. — Attention has very frequently been called to the presence of large amounts of arsenic in green tarlatan, which has given rise so many times to dangerous symptoms of poisoning when made into dresses and worn, so that it is very rare now to see a green tarlatan dress. This fabric is still used, however, to a very dangerous extent, chiefly for the purposes of ornamentation, and may often be seen embellishing the walls and tables at church and society fairs, and in confectionery, toy and dry-goods stores. The writer has repeatedly seen this poisonous fabric used at church fairs and picnics as a covering for confectionery and food, to protect the latter from flies. As is well known, the arsenical pigment is so loosely applied to the cloth that a portion of it easily separates upon the slightest motion. Prof. Hoffmann after examining a large number of specimens estimated that twenty or thirty grains of the pigment would separate from a dress per hour, when worn in a ball-room.

But green tarlatan is not the only fabric which contains arsenic. We find arsenic sometimes in other substances used in making articles of wearing apparel, usually in the form of arsenical pigments. The writer detected a large amount of arsenic in a specimen of cloth known as "Foulard cambric," which had been made into a dress; after wearing the dress a short time severe conjunctivitis was produced, together with nasal catarrh, pharyngitis, and symptoms of gastric irritation. The pattern of the dress consisted of alternate stripes of light-blue and navy-blue, and contained 0.291 grm. per square meter.* Conjunctivitis has also been recorded from wearing of "tulle" dresses.† A pustular eruption upon the neck and arms was caused by "a splendid dark-green dress, trimmed with light-green leaves," obtained "from a well-known Parisian *atelier;*" the dress was found to contain "a large percentage of arsenic."‡

Excessive irritation of the skin has frequently been caused by wearing stockings colored with an arsenical pigment. The writer has detected arsenic most frequently in light-red, magenta-colored and brown stockings; in one case, that of a child, which came to the writer's knowledge, great inflammation of that portion of the skin which came in contact with the stocking took place first, then occurred symptoms of general poisoning, which resulted in a short time in death.

Dr. Jabez Hogg § reports also among other articles of wearing apparel fatal cases of poisoning from the green flannel lining of boots, and poisoning by maroon flannel shirts, by calico shirts, gloves, coat sleeves, hat linings, and paper collars.

Arsenic is used in linen glaze and paper collars to increase the brilliancy of the finish. The editor of the "Medical Press and Circular" says,‖ "On more than one occasion we have mentioned the various domestic sources of chronic poisoning by arsenic, but lately the 'Sanitary Record' has discovered a fresh one, where few would have expected to find one. 'The use of paper collars and cuffs becoming so general, and the great competition in trade, has induced some manufacturers to introduce arsenic into the dressing used to produce that beautiful gloss which seems peculiar to some make of collars. I was induced to analyze some, because a patient of mine had every symptom of arsenical poisoning, and the result was that I obtained 10.4 grains of arsenic in one collar.'" A case of poisoning in a young man was finally traced to the glaze on a linen collar, which was a mixture of starch and arsenic. "The old negress who got up the linen had acquired quite a reputation for the brilliancy of the polish she produced."*

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* See case 38.

† Report presented to the Medical Society of London by a committee. Practitioner, 1880, xxiv, page 235.

‡ The Lancet, May 22, 1880, from Neue Freie Presse.

§ Medical Press and Circular, July 23, 1879.

‖ Editorial, July 2, 1879.

Numerous instances of the production of an eruption upon the forehead by arsenical hat-bands have been recorded. The symptoms are usually limited to the local eruption, which disappears upon the removal of the cause. The following case may be mentioned as illustrating exceptional severity of the affection: "A gentleman also consulted Mr. Hogg for dimness of sight and a severe eczema of the forehead. The eczema had troubled him for several months. Since its appearance the sight of one eye had become dim. The eruption proved very intractable, and, in one of his visits, Mr. Hogg questioned him closely about the wall-paper of his rooms; but these, he was assured, were non-arsenical. A visit to the country effected what medicine could not; it cured the eczema; but, on his return to his duty, the eruption reappeared. Three weeks ago, on entering Mr. Hogg's room, he placed his hat on the table, and the bright maroon having at once attracted Mr. Hogg's notice, he suggested that the hat-lining was the cause of the eczema. A portion was removed and examined for arsenic, and a considerable quantity was found. The use of the hat was discontinued, and the eruption quickly disappeared. He was, however, curious about the matter, and thought he should like to be convinced of the poisonous nature of the lining. The hat was taken out, and placing it on his head, he left home. The forehead became irritable, and on the second day the eruption reappeared. He was now thoroughly convinced. The improvement that took place when he went to the country is explained by the fact that during his stay he almost invariably wore a wide-awake, and not the usual chimney-pot hat." †

Of other fabrics which have been found by us to be arsenical, and which have given rise to symptoms of poisoning, are cretonnes used for covering furniture, for lambrequins, and for bed-hangings, chintz window-curtains, cloth linings for baby-carriages, and cloth for carpets; the writer has also found a specimen of garnet woolen brocade, intended for use as a bed-hanging, to be highly arsenical.

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* Sanitary Record, April 25, 1879, page 271, from The Scientific American.

† British Medical Journal, Nov. 8, 1879, page 746.

Little can be added concerning poisoning by artificial flowers. Dr. Draper has treated thoroughly the subject of their manufacture, and the symptoms produced by them when arsenical. It is important, however, to remember that not only the green leaves, which contain arsenite of copper, but also the flowers, may be poisonous from containing arsenical anilines. The two following cases, reported by Hoffmann and Ludwig,* may be mentioned as illustrating poisoning from arsenical anilines, and the severity of the symptoms which they may give rise to in those who habitually handle them. A woman, sixty-three years of age, and her daughter, twenty-two years of age, were engaged in making crosses from artificial moss and flowers, a very large number being made during the few weeks before All-Souls' Day. The first year both were poisoned, but the poisoning was only temporary; on the second, however, the symptoms were very severe; the daughter recovered after several months, but the mother died. After death extreme fatty degeneration of the liver, kidneys, heart and muscles was found, and chemical analysis showed the presence of arsenic in all of the tissues except the bones, the largest amount being found in the brain and liver. The source of the poisoning was traced to the arsenical fuchsine used for coloring the artificial flowers; of six different kinds of fuchsine found in the shops only one was free from arsenic.

Articles of Food. — Arsenical poisoning due to the presence of arsenical pigments in confectionery and articles of food, is fortunately very rare at the present time, yet cases have occurred, more frequently between ten and twenty years ago than during the last decade. This diminution in the frequency has undoubtedly been due to the frequent detection of Scheele's green in candies, and the publication of the results of such analyses, by which the public has gradually become informed as to its possible presence in green confectionery and also as to its poisonous nature. When arsenic is found nowadays in green confectionery, it is always in some portion intended rather for ornamental purposes than as an article of food.

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* Wiener med. Jahrbuch, 1877, page 501.

The following case of poisoning by a toy watch illustrates the manner in which the pigment may get into the candy: Two children were seen by a physician apparently suffering from the effects of some irritant poison. "On inquiry it was found that they had quite recently eaten some sweetmeats made in the form of a watch. The parents produced one, the outer rim of which was composed of sugar colored pink. The face was green printed paper pasted on behind, and overlapped the rim fully one-half its breadth. When this green paper was removed, a portion of the green pigment adhered to the sweetmeat; and, on submitting this to analysis, it was found to be arsenite of copper. The quantity on the entire face of the watch was estimated at eighteen grains of arsenic."* No cases, so far as we have been able to learn, of poisoning by confectionery colored with other arsenical pigments have been reported. This may be due to the fact that the coloring power of these pigments is so great, and the proportion of arsenic contained in them so small, that the disturbance created by the arsenic in any amount of candy liable to be eaten at any one time would be very slight and likely to escape special notice, since it would be referred rather to the candy itself than to the coloring matter.

Arsenical colors are sometimes used for fraudulently coloring red wines and syrups, but the amount of arsenic contained in a single bottle of wine or syrup colored with arsenical fuchsine, for instance, would be very small, so that serious symptoms of poisoning would not be produced by an occasional indulgence.

Of the domestic *sources of acute arsenical poisoning*, by far the most important one is German fly-paper, which, as mentioned above, is made by soaking a coarse bibulous paper in a strong solution of arsenite of sodium, and allowing it to dry. In using this for the purpose of destroying flies, it is customary to place a piece of the paper in a plate or saucer, and moisten or cover it with sweetened water. The flies, after partaking of the sweetened mixture, are poisoned by the arsenic, and are found dead in all parts of the room.

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* British Medical Journal, Nov. 8, 1879, page 746.

The greatest danger consists in placing the plate or saucer with the moistened paper — and frequently with quite a large amount of water — within the reach of young children. The writer has been informed by those personally familiar with the facts of three cases of fatal poisoning in children. The children in each case succeeded in reaching the saucer, and either drinking the excess of arsenical fluid or putting a piece of the paper in the mouth, with the result of producing fatal acute arsenical poisoning.* Similar compounds of arsenic with alkalies, such as arsenical soaps used for the destruction of vermin on animals, are sometimes used, and give rise frequently to eruptions upon the skin of those using them, and may cause acute poisoning if, by accident or design, any be swallowed; a solution for washing sheep is made by dissolving arsenic in soft soap.

Paris green, which is used so largely for the destruction of potato-bugs, is a compound of arsenic and copper, and may contain from thirty to sixty per cent. of arsenic. Numerous fatal cases of suicidal poisoning have recently occurred, and been reported in this vicinity, with many of which the writer has been personally familiar.

London purple, which is a waste product resulting from the manufacture of certain aniline pigments, is also used for the destruction of potato-bugs. One specimen analyzed by Dr. C. Harrington, was found to contain seven and one-half per cent. of arsenic.

The "Buffalo Carpet-Moth Annihilator" is used for the destruction of this household pest, which has only been introduced into this country within a few years. Packages of this poison are labelled as follows: — "This remedy contains neither hellebore nor carbolic acid: it has no offensive odor, and can be used anywhere, as it leaves neither color nor stain. This insect antagonist or compound should be sprinkled beneath your carpets, and especially along the edges. . . Should be used freely in trunks, closets, and drawers, and wherever woolen, cotton, or silk materials are packed or stored. In all places and crevices favorable to vermin it should be used, and will be found especially efficacious in the putting away of furs." One specimen of this powder analyzed by Dr. C. Harrington was found to contain 6.726 per cent. of crystals of white arsenic.

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* See case 39, page 254.

"Rough on Rats" is a grayish powder which also contains white arsenic crystals.

The committee of the National Health Society appointed to report upon this subject, at the conclusion of their report presented the following list in the form of an appendix.*

Articles in which Arsenical Pigments, Dyes, or Mordants are used, within the knowledge of the sub-committee. — Paper, fancy and surface-colored; in sheets; for covering cardboard boxes; for labels of all kinds; for advertising cards; for playing cards; for wrappers and cases for sweetmeats, cosaques, etc.; for the ornamentation of children's toys; for covering children's and other books; for lamp shades; paper-hangings for walls and other purposes; artificial leaves and flowers; wax ornaments for Christmas trees and other purposes; printed or woven fabrics intended for use as curtains or covering for furniture; printed or woven fabrics intended for use as garments; children's toys, particularly inflated India-rubber balls with dry color inside; painted India-rubber dolls, stands and rockers of rocking-horses, and the like; glass balls (hollow); distemper color for decorative purposes; oil paint for the same; lithographic color printing; decorated tin plates, including painted labels used by butchers and others to advertise the prices of provisions; japanned goods generally; Venetian and other blinds; American or leather cloth; printed table baizes; carpets; floor-cloth; linoleum; book-cloth and fancy bindings.

Mode of Introduction. — Of course, some of the pigments which are used in the coloring of textile fabrics and other articles of domestic use are known, when used, to be arsenical, such as the various greens, which are compounds of arsenic and copper, and known by various names, as Scheele's green, Schweinfurt green, Paris green, emerald green, *vert de Mittis*, and several other names. This is not always the case, however, and in many cases the introduction of the arsenic is unintentional and unsuspected, yet it is just as dangerous to the public health, and should be guarded against as strenuously as in the case of pigments known to be arsenical.

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* British Medical Journal, June 23, 1883, page 1218.

Arsenic is introduced into articles for domestic use in the form of some coloring matter which is a compound of arsenic, like the compounds of arsenic and copper in the above mentioned green pigments, or like the compounds of arsenic and sulphur, the principal of which are orpiment and realgar, yellow and orange pigments, and some of the aniline pigments, such as the arseniate of rosaniline; in all of these the arsenic enters into the composition of the coloring matter as a chemical constituent, and cannot be separated from it without destroying the nature of the pigment. In other cases the arsenic is simply used in the process of manufacture of the pigment, is not essential to its nature, and can be entirely removed from it by proper purification; the purification, however, entails some loss of the coloring matter itself, and necessarily increases its cost. This is true of some of the aniline colors, as fuchsine, magenta, and the like. The following description of the process for the manufacture of magenta will explain the extent to which arsenic is sometimes used. "By far the largest part of the magenta made, not only for use in dyeing, but also for conversion into other aniline colors, is prepared by the arsenic acid process devised by Mr. Medlock. . . The manufacture of magenta, as it is now conducted in the large color works, is a comparatively simple process; the apparatus employed consisting of a large cast-iron pot set in a furnace, provided with means of carefully regulating the heat. . . Into this apparatus, which is capable of holding about 500 gallons, a charge consisting of 2,740 lbs. of concentrated solution of arsenic acid, containing 72 per cent. of the anhydrous acid, is introduced, together with 1,600 lbs. of commercial aniline. . . After the materials have been thoroughly mixed by the stirrer, the fire is lighted, and the temperature gradually raised to about 360° F. . . The temperature should not exceed 380° F. at any period during the operation. When this is complete, steam is blown in through a tube provided for that purpose, in order to sweep out the last traces of free aniline, and boiling water is gradually introduced in sufficient quantity to convert the contents into a homogeneous liquid; when this occurs, the liquid is run out at the openings at the bottom into cisterns provided with agitators: here more boiling water is added, in the proportion of 300 gallons to every 600 lbs. of crude magenta, and also 6 lbs. of hydrochloric acid. The mass is then boiled for four or five hours by means of steam pipes, the agitators being kept in constant motion. The solution of hydrochloride, arsenite and arseniate of rosaniline thus obtained is filtered through woolen cloth, and 720 lbs. of common salt added to the liquid for each 600 lbs. of crude magenta. By this means the whole of the rosaniline is converted in hydrochloride, which, being nearly insoluble in the strong solution of arseniate and arsenite of sodium produced in the double decomposition, separates and rises to the surface. . . In order to purify the crude rosaniline hydrochloride, it is washed with a small quantity of water, redissolved in boiling water slightly acidulated with hydrochloric acid, filtered, and allowed to crystallize." *

Several crystallizations are necessary to ensure perfect freedom from arsenic; each recrystallization would, of course, diminish the amount of the finished product, and thereby increase the cost. The use of arsenic is not necessary, however, in the manufacture of magenta or aniline red, and several other processes have been devised, which result in the production of a non-arsenical color. Safranine, a pink aniline dye, is also sometimes made with arsenic acid, but other oxidizing agents are preferable. An arsenical solution is used in printing with this color, which "is now superseding safflower, or carthamine, as a red dye for silk." †

In the manufacture of aniline maroons and browns, magenta is sometimes used, and hence these colors are liable to be more or less arsenical, according to the quantity of arsenical magenta used.

Fabrics which are colored with non-arsenical colors, may be rendered arsenical by the use of mordants which contain arsenic, often in very large quantities, as may be seen by the following recipes, taken from Calvert's work on "Dyeing and Calico Printing."

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* Dyeing and Calico Printing: by the late Dr. F. Grace-Calvert, F.R.S., F.C.S., page 365.

† Ibid., page 382.

For printing with madder purple : —

For Light Purple.

1 gallon of acetate of iron at 1½° T.
3 gallons of purple assistant liquor.
3 gallons of water.
18 lbs. roasted farina.

For Dark Purple.

7 gallons acetate of iron at 2½° T.
¾ gallons purple assistant liquor.
3 lbs. flour.

The purple assistant liquor is made as follows : —

1st 100 gallons wood acid.
9 lbs. yellow prussiate of potash are dissolved in the wood acid.
2 gallons sulphate lead precipitate, made by dissolving acetate of lead in water, precipitating with sulphuric acid, and allowing the sulphate of lead to subside.
2d. 50 lbs. carbonate of soda, dissolved in 8 gallons of water, to which is added 50 lbs. arsenious acid; when this is dissolved it is added to the first mixture, and thoroughly incorporated by stirring.*

Printing with madder extract : —

For Dark Purple.

Boil together one litre of extract (Pernod's) in paste.
1 litre of acetic acid at 8° Baumé.
224 grammes of olive oil.

The acid which is evaporated is replaced, and the mixture is thickened with 600 grammes of powdered gum Senegal. When required for use there is added,—

224 grammes of black mordant at 10° Baumé.
128 grammes of arsenite of soda at 6° Baumé.†

For printing with artificial alizarin : —

For a Red.

Take 2,500 grammes alizarin.
8,000 grammes thickening.
500 grammes acetate of alumina at 10° Baumé.
250 grammes chalk at 16° Baumé.

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* Ibid., page 73.

† Ibid., page 97.

The red is obtained by adding one part of this mixture to two parts of thickening, then printing and steaming. It is afterwards passed through a bath heated to 120° or 140° F., and composed of 1,000 litres of water, 30 kilos. of chalk, and 1½ kilos. of chloride of tin, or 20 kilos. of chalk and 5 kilos. of arseniate of soda; it is then brightened.*

After printing with a purple alizarin:—

"The printed fabrics are steamed under a pressure of half an atmosphere for twenty-four hours. They are then passed for two hours in a bath of arseniate of soda (5 kilos. arseniate, 20 kilos. chalk, and 1,000 water) at 120° to 140° F., washed and brightened in a bath of soap (3 kilos. of soap to 20 pieces of fifty yards)." †

In one process for printing calico with magenta, "the color is first printed on with a thickened mixture of sodium arsenite, and aluminium acetate, the proportions being:—

1 litre of acetate of aluminium, at 10° B.
80 grammes of arsenite of sodium.
16 grammes of magenta." ‡

The above examples suffice to show how extensive is the use of arsenic, both in the manufacture of coloring matters, and in fixing them upon textile fabrics. One other source of arsenic, especially in wall-papers, has already been alluded to above; viz., the use of white arsenic in preventing the decomposition of the paste used either in fixing the colored material upon the paper or the paper upon the wall.

Effects and Symptoms. — The effects produced by arsenic, when used in the various domestic substances mentioned in the foregoing pages, varies very greatly with the circumstances; such as the length of time during which the individual is exposed to its influence, and the number of hours in each twenty-four, the manner in which the arsenic comes in contact with the individual, and the portion of the skin or mucous membranes which is especially exposed to its action. The effect also varies according to individual peculiarities, or, medically speaking, according to the idiosyncrasy in each individual case, *i. e.*, different individuals exposed to the action of the arsenic in precisely the same manner and under precisely the same conditions, may be affected very differently by it. Conditions of the atmosphere, especially as to the degree of humidity, affect the action of the arsenical substance very much, especially in the case of wall-paper, a very moist atmosphere increasing its effect, probably by favoring the decomposition which always takes place when arsenic is allowed to remain in contact with moist organic matter, by which a very poisonous gas, arseniuretted hydrogen, is evolved. That this gas is found in rooms papered with arsenical wall-paper is now proved beyond a doubt by the experiments of Hamburg,* Bartlett,† and others, who have detected arsenic in the air of such rooms after the air had been freed from any arsenical dust which it may have contained by filtering through cotton wool.

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* Ibid., page 100.

† Ibid., page 101.

‡ Ibid., page 378.

The nature of the material which contains the arsenic, and the uses to which it is applied, naturally give rise to the greatest variation in the effects produced. Articles of clothing, for instance, produce much greater effect, if directly in contact with the skin, or if the arsenic is in such a form as to be more or less soluble in the secretions of the skin.

Many of the compounds of arsenic which are insoluble in water, are more or less readily affected by the fluids of the body. Arsenite of copper (Scheele's or Paris green), for instance, is very readily dissolved by the gastric juice, and produces acute poisoning when taken internally, and always causes an eruption upon the skin when in contact with it for a certain length of time, as in the case of manufacturers of artificial leaves and arsenical green wall-papers. ‡

It is obviously as impossible to give a description of the effects or symptoms produced by arsenic, when contained in wall-paper or other domestic substances, which will apply to every case of such form of poisoning, as it is with acute arsenical poisoning or with many diseases. In acute arsenical poisoning, for instance, the symptoms may vary very decidedly in different cases; thus, in most cases there are marked symptoms of irritation or inflammation of the stomach and intestines, shown by vomiting and purging, but in some fatal and very acute cases these symptoms may be entirely wanting, and only those be present which show very decided effect upon the nervous centres, and in which the symptoms resemble those of a narcotic poison.

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* Zeitschrift für Biologie, viii, page 444.

† The Analyst, April, 1880, page 81.

‡ *Vide* Dr. Draper's report.

The symptoms or effects of arsenical poisoning, when due to its presence in articles of domestic use, may be divided into local and general. The local effects are those which are produced by the direct action of the arsenic upon that portion of the body with which it comes in contact, as with the skin and mucous membranes, especially of the eyes, nose, mouth, and throat. The general effects are those due to the action of the arsenic after it has been absorbed into the circulation, and are shown by the nervous disturbances, great prostration, etc.

Local Symptoms. — These are almost entirely inflammatory, and confined to those portions of the skin or mucous membranes with which the arsenical dust comes in contact. The portion of the skin most liable to be affected varies naturally with the employment, and with the nature and manner of using of the arsenical substance. The mucous membranes most liable to be affected are those of the eyes, nose and throat; in some cases, especially if the exposure to the arsenical dust be long continued, the membrane of the air-passages, causing bronchitis and asthma, and those of the stomach and intestines, causing indigestion, with sometimes vomiting and diarrhœa, are affected. These symptoms of inflammation of the mucous membranes do not yield to the ordinary methods of treatment, unless, at the same time, there is no more exposure to the arsenic; or, if there is any improvement, it is usually slight and of short duration.

The affection of the eyes has been well described by Mr. Hogg, as follows: "The local symptoms are of a severe catarrhal nature — as running of the eyes and nose; turgidity of the superficial vessels, chiefly of the conjunctival; on closer inspection of the sclerotic, also, a faint zonular zone is seen, and which explains the orbital pain at night. A feeling as if some mechanical irritant were lodged between the eyelids and the eyeball, from which circumstance the cornea frequently suffers, as there is a constant desire to remove the supposed body or grit from the eye; a vesicle appears at the lower margin of the cornea, and a pustular eruption about the Meibomian follicles; the discharge becomes muco-purulent, and the symptoms pass to the chronic stage, ciliary blepharitis; the cilia fall out, nebulous opacities of the cornea appear, and the case is of an unusually obstinate character. The dimness of sight complained of depends entirely upon the viscidity of the discharge, and the haziness of the cornea thereby produced, than to any actual loss of visual perception; the other symptoms partake of a more general or constitutional character, as tension and swelling of the lids, an erythematous blush over the cheeks, irritation of the Schneiderian membrane, severe fits of sneezing, and bleeding of the nose. The disease is pretty much the same whether it occurs in the child or the adult, and does not yield to ordinary remedies." *

The catarrhal nose and throat symptoms are usually referred to a simple catarrhal attack due to taking cold, and are similar to those of an ordinary cold. These symptoms are worse after exposure; when due to arsenical paper in the sleeping-room, the symptoms are much worse in the morning, rapid improvement taking place often during the day, if the room is not occupied. In some cases the symptoms are much worse after the room has been dusted or swept. In addition to these symptoms some patients are liable to be attacked with a severe bronchitis and spasmodic asthma, when the attack resembles one of "hay fever."

The stomach and intestinal symptoms are in most cases partly due to the local action of the arsenical dust, which, after coming in contact with the mucous membrane of the mouth and throat, is swallowed with the saliva, and after being swallowed it may cause irritation and inflammation of the stomach and intestines, in rare cases to such an extent as to produce fatal acute arsenical poisoning. These symptoms are, however, usually mild, and supposed to be a so-called "bilious attack" or simple indigestion, with the usual loss of appetite, feeling of lassitude, headache, etc. Sometimes diarrhœa or even bloody stools are produced. These digestive disturbances may be entirely wanting in certain

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* Sanitary Record, April 25, 1879, page 257.

cases of wall-paper poisoning, or they may be the principal symptoms in the case, and the only ones which are noticed.

General Symptoms. — These are due to the action of the arsenic upon the system after it has been absorbed. This action shows itself most prominently by nervous disturbances, although some of these may be due to the affection of the mucous membranes described under the local symptoms. They are shown by more or less severe neuralgic pains in varying portions of the body, attacks of dizziness, severe headaches, drowsiness, loss of energy, and inability to perform any severe mental or physical work, a feeling of great depression, nervous prostration, repeated attacks of fainting, trembling of the limbs, and even arsenical paralysis in aggravated cases.

These symptoms are never all present in the same case, but that they may be caused by accidental arsenical poisoning in wall-paper and other arsenical articles cannot be doubted, in the light of the evidence which we have at the present time. Only a small portion of this evidence will be given below, but a sufficient number of well authenticated cases to illustrate the above classes of symptoms are mentioned.

There is no doubt also that these same symptoms may be seen in patients suffering from other diseases than arsenical poisoning, and the diagnosis can often only be made by removal of the cause, when in many cases complete recovery ensues, as if by magic, whereas before, the disease had resisted every kind of treatment, except removal from the arsenical influence. There can also be no doubt that there are more cases of this form of poisoning overlooked, the symptoms being ascribed to some other cause, than are reported.

All medical men know how commonly the terms "general debility," "nervous prostration," and the like, are used in medicine without the physician's having the slightest idea, in many cases, as to the cause of such serious disturbances of the general health; and I think that, even in the obstinate cases, those which resist all ordinary treatment, it is rare for medical men to think of arsenic in domestic articles as a possible cause. In many cases, also, when recovery takes place after a change of scene, such as a vacation in the country or at the sea-shore, or a sea voyage, the removal from the influence of some domestic poison is not thought of. Hence the great difficulty in the detection of this form of poisoning, and in the collection of statistics in regard to it. These difficulties are exhaustively treated by the eminent English authority, T. Lauder Brunton, M.D., F.R.S.,* as follows : —

> "The evidence on this subject consists partly of articles published in various journals, and partly of answers to a circular on the subject sent out by the Medical Society of London. † The nature of the evidence is, first, that certain symptoms have occurred in persons exposed to the influence of certain conditions; second, that, on attempting to analyze these conditions with the object of finding out the cause of injury, none could be discovered at all likely to produce the symptoms, except arsenic; third, that the symptoms coincide in many respects with those produced by arsenic when administered internally; fourth, that the symptoms disappeared when the arsenic was removed, although, so far as could be ascertained, the other conditions remained unaltered. The number of cases on which the report of the committee of the Medical Society of London was based, was a little over one hundred; and, besides these, numerous cases have been reported in medical journals. Considering the extensive use of arsenic in wall-papers and articles of clothing and furniture, the number of cases may appear very small, and quite insufficient to prove the necessity for any form of legislative interference. This objection we believe, however, to be invalid. It is exactly the same in kind as that which may be brought against interfering with systems of drainage which contaminate drinking-water with typhoid excreta, or against the free distribution of milk supplied from dairies where typhoid or scarlet fever exists. The comparative smallness of the number of cases of poisoning by arsenical wall-paper is, we believe, simply due to ignorance of the injurious action of arsenic in papers, dress or furniture, and consequent failure to perceive the connection between the illness and its cause. One circumstance which renders this connection more easily overlooked, is the fact that all persons are not equally susceptible to the injurious action of arsenic. It is well known that, in Styria, many persons are

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* "Report on Evidence Regarding the Injurious Effects on Health Arising from Arsenical Wall-papers, and other Articles containing Arsenic." [*British Medical Journal, June* 23, 1883, *page* 1218.]

† See British Medical Journal, Feb. 21, 1880.

accustomed to take quantities of arsenic which would be fatal to others unaccustomed to it. It seems possible that the same may occur with arsenical papers; for, in a house at Hampstead, where the former occupant had enjoyed good health, another family, shortly after their entrance, began to suffer from symptoms of arsenical poisoning. The wall-paper was examined and found to be arsenical. On its removal all the symptoms ceased. The immunity which the first of these families enjoyed, although exposed to the action of the arsenical paper, may have been due to their having become gradually inured to the presence of arsenic; but it may also have been due to a less degree of sensitiveness; and this is all the more probable, because the second family have suffered three several times in the same way. Should one member of a family be more sensitive than others, he or she may suffer while the rest escape. In such a case, suspicion will be averted from the arsenical paper, as all have been exposed to its influence. In one case reported to the Medical Society, two children of an eminent consulting surgeon died from enteritis, while the nurses escaped. The cause of the illness and the death of the children was a mystery, until the nursery papers were examined and found to contain arsenic. Another cause of the failure to connect the symptoms due to arsenic with its presence in wall-papers is, that the symptoms are those of irritation of the intestines or respiratory tracts, or of the conjunctivæ; and these may frequently be attributed to other causes than the true one, especially if no suspicion of the presence of arsenic be entertained. Thus, in thirty-five cases reported to the Medical Society, nausea, diarrhœa and digestive disturbances occurred; and these symptoms might be ascribed to errors in diet, to chills, to imperfect drainage, or to worry or overwork; or might be vaguely ascribed to constitutional disturbance, by those who did not suspect, and therefore failed to discover, the true cause. The same may be said of the cough and asthma, which occurred in nine cases, or of the conjunctivitis which occurred in nineteen. In support of this view, it may be mentioned that one-fourth of the cases of poisoning reported to the Medical Society had occurred in the persons of the medical men themselves or in members of their families, and that a large proportion of the cases reported had been observed by men qualified in an especial way, either by knowledge or by training, to discover the true cause of the symptoms which occurred. . . .

"At all events, however, a considerable amount of positive evidence has already been obtained of the injurious action of arsenical papers and fabrics; and whatever may be the reason why it is not greater, it is sufficient to justify vigorous action in the matter."

The committee of the London Medical Society say, in their report referred to in the above article: — "A most important feature in this testimony is that no fewer than twenty-four instances of the poisoning occurred in the persons of the medical men themselves, or in members of their families, which . . . tends to show that the better opportunities for observation afforded to a medical man in his own house may lead to the detection of the mischief which, from its insidious nature, baffles ordinary tests, or, by assuming symptoms of a general character, is often erroneously treated as indicating a different class of ailments."

That arsenic is absorbed into the body in cases of poisoning by arsenical wall-paper has been proved by the detection of arsenic in the urine of patients suffering from this form of poisoning. In one case,* in which the illness was directly traced to arsenical wall-paper, analyses were made of the dust in the room and of the excreta of the patient, with the following results: —

	White Arsenic.	Scheele's Green.
100 grains of dust from top of wardrobe, . . .	0.20	0.36
100 grains of dust from same room, ...	0.16	0.30
48 ounces of patient's urine, ...	0.26	0.50

The writer has also detected the arsenic in the urine of a patient suffering with arsenical wall-paper poisoning. Mörner † reports the presence of arsenic in the urine of those poisoned by arsenical wall-paper. His analyses were performed with the greatest care and accuracy, parallel analyses having been made.

Illustrative Cases. — The following cases are given to illustrate the important points which have been mentioned above. They have been mostly selected from European medical journals, where the most active measures have been taken to suppress the sale and use of poisons in articles of food and of household use. Many more might have been cited, but the following are sufficient to prove beyond any reasonable doubt the injurious effects of arsenical papers and fabrics, and to show how these substances may affect different individuals in a very different manner.

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* British Medical Journal, June 21, 1873.

† Virchow-Hirsch Jahresber., 1876, I, page 405.

Cases illustrating great severity: —

1. "A distinguished consulting surgeon lost two children from enteritis. The cause of the illness was a mystery until after their death, when the nursery paper, the pattern of which was a fuschia, leaves and blossoms on a brown ground, was found to contain arsenic." *

2. A gentleman suffered with all of the symptoms of a severe cold a day or two after occupying a room at a hotel; these symptoms were attributed to the damp condition of the walls. The next night he occupied a room at a cottage, the walls of which were covered with an arsenical green paper. Shortly after entering this room he was seized with chills, so severe that his teeth chattered; he was so weak that he had not strength enough to get out of bed, an attempt to do which produced violent pain in the bowels, followed by "dreadful sickness." After intense suffering for a time, he fainted, and knew nothing more until eight o'clock the next morning, when, upon recovering consciousness, he noticed the bright green color of the paper. He felt much better as soon as removed from the room, although scarcely able to dress. "In my opinion, the acute nature of the symptoms experienced by the patient was mainly due to a saturated atmosphere of arseniuretted hydrogen, arsenical dust being of a less diffusible nature. The humid state of the surrounding air, which was at the same time the subject of remark, possibly facilitated the evolution of the poisonous gas." †

3. Prof. Osborne Reynolds' case: "Many lives, I find, have been sacrificed to the absorption of arsenical wall-paper poison. From out of a family of six persons, the father, mother, and four children were poisoned within a short period of each other. Three of the children had died from what was supposed to be diphtheria, when Dr. Orton, of Stepney, was called in to the fourth child, of about ten years of age, who was then in the last stage of illness from what was believed to be the same form of disease. Not many hours elapsed before this gentleman's attention was attracted to a bright green wall-paper on the bedroom walls in which

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* Report presented to the Medical Society of London on the part of a committee of the Society. Practitioner, 1880, xxiv, page 235.

† Jabez Hogg, M.R.C.S., British Medical Journal, June 14, 1879.

the child lay. He passed his hand over it, and found that a quantity of the color came off, which he at once suspected to be Scheele's green. On submitting it to the late Dr. Letheby, his suspicions were in a measure confirmed, but too late to save the child's life. On inquiry, it appeared that the rooms had been re-papered about Christmas, and very soon afterwards parents and children complained of great irritation of the eyes and nose; of headache, thirst, sore throat, and pains of the abdomen. The inflammation of the throat increased, and ended in sloughing of the fauces, and from which the four children actually died in the course of as many months from the time when the first symptoms of ill-health were noticed." *

The following cases illustrate the fact that acute poisoning may be due to the accidental ingestion of portions of the poisonous pigment on wall-paper, and also show how easily the symptoms of chronic poisoning may be overlooked, until some accident occurs to attract attention to them.

4. Two children were attacked one morning, before breakfast, with vomiting, painful cramps in the abdomen, and diarrhœa. Upon inquiry, it was learned that they had been re-decorating the walls of their bedroom by painting them, using their fingers as paint-brushes, and obtaining the paint by mixing the color of the wall-paper, which was arsenical, with saliva. These children had for a long time suffered from more or less conjunctivitis, a spongy condition of the gums, a freaky appetite, and other symptoms of chronic wall-paper poisoning, the cause of which had never been suspected until this acute poisoning called attention to it. †

5. A gentleman and his wife had suffered for a long time with considerable digestive trouble, such as loss of appetite, occasional vomiting, slight diarrhœa, etc. They went away into the country and recovered, but attributed their recovery to yarrow (*Achillea millefolium*), which they had taken while in the country; consequently they carried home a large quantity of the herb, and hung bunches of it upon a nail against the wall-paper to dry. After having been home

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* Sanitary Record, April 25, 1879.

† Dr. J. Stevens, The Lancet, May 10, 1879, page 686.

for a short time, the former symptoms returned; therefore they made a decoction of the herb, as they had done while in the country, and took it, but with very different result, since the herb by hanging against the arsenical paper had become covered with arsenical dust, and gave rise, when taken, to acute arsenical poisoning. The wife vomited very soon after taking her portion, so that nearly all of the arsenic was expelled quickly, but the husband lay down and had a nap; he woke with great pain in the stomach and bowels, abdominal cramps and diarrhœa. The cause of the poisoning was finally traced to its proper source, the arsenical wall-paper, after the removal of which the old symptoms did not recur.*

Cases illustrating catarrhal symptoms: —

6. Cases of poisoning by wall-paper containing about one-half of a grain of Scheele's green to the square foot: "Mr. and Mrs. R. and family, consisting of two little girls, aged respectively five and three years, and a baby nine months old, together with two maid-servants, went to reside in a newly-built, freshly-papered house, about to be opened as a hotel in New Basford, at the end of July last. The rooms were papered throughout with papers of two different patterns, both of which were colored with pigment containing Scheele's green in the proportion of 0.596 and 0.522 grains per square foot respectively, as was subsequently shown by the analysis of Dr. Truman, the borough analyst. The walls were noticed to be very damp when Mr. and Mrs. R. began to occupy the house; and, the weather at that time being very warm, the windows were habitually kept wide open, as it was thought they would dry more rapidly. Five weeks afterwards it turned colder; and, as they were still damp, Mr. R. then ordered the windows to be kept shut, and fires lighted throughout the house. Within a period varying from five to thirteen days of this, every member of the household, with one exception, suffered from symptoms undoubtedly due to arsenical poisoning. The children were affected first, The baby had conjunctivitis and vomiting; the two older ones had 'running at the eyes and nose' so marked that Mr. Hatherly, when he first saw them, attributed the symptoms

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* Dr. J. Stevens, The Lancet, May 10, 1879, page 686.

to a commencing attack of measles. At a subsequent visit, however, he found Mrs. R., who had before complained of headache, suffering as well from sore throat and epigastric pain. Further inquiry elicited the fact that both the servants had 'sore throat, swollen eyes and headache;' that one of them had been so ill that her mistress had sent her home for a few days. She there rapidly recovered, but on her return suffered in a similar manner. The only member of the household who did not suffer in an evident manner was Mr. R , and this would be accounted for by the fact that he was a great deal from home at the time. As soon as the suspicions were confirmed by an examination of the papers, the walls were stripped, and in a few days the patients were well." *

7. The following case is that of a physician and is best given in his own words: — "I have occupied my present rooms since the beginning of the year; previously, I had been perfectly healthy in every respect. About March, I began to be troubled with an irritating bronchial cough, with expectoration of mucus and muco-pus. I noticed especially that every night on going to bed, there was much wheezing and coughing. I attached little importance to these symptoms at first; in fact, not until they had lasted six or seven months without abatement. I frequently suffered also from sore throat, but there was no other disturbance of the alimentary tract. Occasional coryza with sneezing was present; but this was not a marked symptom. For some time I thought I might be suffering from hay fever; but this was disproved by the symptoms continuing through the summer and autumn.

"About a month ago, severe conjunctivitis came on, first in the left eye, then in the right, and lastly in both together. This was comparatively mild in the morning, but increased in severity towards night, when there was a plentiful secretion of thick mucus. It was on the appearance of this symptom that my partner, Mr. Wyke-Smith, suggested poisoning by arsenic. My bedroom paper was innocent of suspicious color; but my sitting-room paper contained a good deal of dark green, amongst other colors. . . . There

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* Dr. Edward Seaton, British Medical Journal, June 24, 1880, page 127.

was great irritability of the skin as well as of the bronchial mucous membrane. I was unable to wear an ordinary gold ring, in consequence of the violent eczema it produced. I had previously worn it for years. This irritation has since disappeared, and I can now wear my ring without discomfort." The sitting-room paper proved to be very arsenical, and after its removal the above disagreeable symptoms disappeared, and did not recur.*

8. The following case of "relapsing bronchitis" is reported by Jabez Hogg, M. R. C. S.† :—" B. A., a little girl, who had bronchitis of the small and medium-sized bronchi, became convalescent about the usual time, but this was attended with extraordinary relapses of such a severe nature that I was sent for during the night to see the patient. The relapses always came on after her little playmates had been running about the room and jumping on the bed. At last I became suspicious of the paper, and found it loaded with arsenic. I collected also the dust on the top of the wardrobé, on the top of the bed, and on the floor, and found all contained arsenic. After removal to another room the child rapidly recovered."

The following case from the same authority illustrates also the severe action which arsenical wall-paper exerts upon the nervous system :—

9. Miss S., a few days after moving into a furnished house, suffered with the symptoms of a cold and cough; this continued to grow worse, and in addition there was frequent sickness at the stomach and pain over the stomach. There was also considerable irritation of the throat, with cough and difficulty of breathing. The general debility increased and was accompanied by fainting attacks, which occurred daily. After the wall-paper was suspected, the lady changed rooms with her maid, after which she rapidly improved, but the maid became sick at the end of a week, and then it was observed that a favorite cat had a peculiar eruption on the skin, attended with loss of hair. The wall-paper was then examined, and "arsenic in abun-

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* Dr. G. H. Batterbury, British Medical Journal, Nov. 18, 1876.

† Sanitary Record, April 25, 1879, page 260.

dance" found. After its removal from the wall Miss S. and her maid speedily recovered.*

10. "Mr. and Mrs. W. and an only child were simultaneously attacked by a painful irritation of the eyes, nose and throat. These symptoms were for some days believed to be due to an ordinary cold caught during the re-papering of the bedrooms. A conjunctivitis with a severe muco-purulent discharge came on, and it was thought prudent to have a consultation. Days passed and no improvement took place; ulcers appeared about the margin of the corneæ, with swelling of the lids, together with unpleasant symptoms of general debility. It was impossible to account for the obstinate character of the disease. At length it occurred that the wall-papers of the bedrooms were suspected, but, as these were French grays, a doubt was expressed. However, on placing specimens in the hands of Prof. Hirsch, F.C.S., he reported them all more or less arsenical." †

11. "A pale-faced, blear-eyed man, twenty-six years of age, consulted me in February for ciliary blepharitis of some standing. For several days he had been unable to follow his employment from the constant orbital pain, increased vascularity and severe lachrymation. He had sore throat, a short, dry cough, difficulty of breathing, and palpitation of the heart. 'He had lost his appetite and could not sleep; and he had been so often under medical treatment that he despaired of ever getting well.' He was a paper-hanger by trade, and suffered severely when he was engaged in hanging green papers. He had heard that these were arsenical; he had frequently suffered from sore fingers. I requested him to bring me a specimen or two of the papers considered to be the most dangerous, and all were found arsenical. Rest and absence from work, together with iron, brought about a great change in this patient." ‡

12. "Mrs. M. D. and a daughter of ten years of age suffered from repeated attacks of acute conjunctivitis, for which she had been upwards of six months under treatment. When they came under my care the disease had already as-

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* British Medical Journal, June 14, 1879, page 892.

† Sanitary Record, April 25, 1879, page 258.

‡ Jabez Hogg, M.R.C.S., Sanitary Record, April 25, 1879, page 258.

sumed the chronic form of ciliary blepharitis; the blear eyes of the child were very unsightly, and the nebulæ of some size occupied both corneæ. From the history furnished, I came to the conclusion that they were the victims of arsenical wall-paper poisoning; and on making a careful examination of the wall-papers they were found highly arsenical." *

13. "A medical man and his wife suffered from headaches, nausea and conjunctivitis, all of which were worse early in the morning. The symptoms abated when the bedroom paper was removed. It contained arsenic." †

14. "A physician, in reporting his own case, says he had 'intense cephalalgia, conjunctivitis with intolerance of light, great depression and loss of appetite, with gastric irritation — worse when using the study, the wall-paper of which contained arsenic.'" ‡

15. Dr. F. Wardropes § reports three cases of poisoning in adult females who were together engaged in papering a room with arsenical paper. In the first case the symptoms were intense headache and catarrh; she "had never suffered in such a manner before from a cold." The second patient had similar symptoms, and gastro-enteric disorders besides, with great pain in the back. In the third case there was periodical headache of great intensity, beginning "at daylight and lasting till four o'clock in the afternoon, with excruciating pains in the frontal branch of the first division, and the auricular and temporal branches of the third division of the fifth pair of nerves, also in the branch of the spinal accessory supplying the sterno-cleido-mastoid muscle." This intermittent neuralgia continued about two weeks.

16. This case, like the last one, illustrates the neuralgic symptoms which may be caused by arsenical paper. A lady, forty-seven years of age, began to be affected with supraorbital neuralgia on the right side, six weeks after occupying a room papered with "a dull grayish artistic green, with red pomegranates." The neuralgia steadily increased in severity, and no benefit was derived from open-

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* Jabez Hogg, M.R.C.S., Sanitary Record, April 25, 1879, page 258.

† Report to the Medical Society of London, Practitioner, 1880, xxiv, page 235.

‡ Ibid.

§ Cincinnati Lancet and Clinic, Aug. 26, 1882, page 217.

air exercise and quinine; it was made worse by Fowler's solution. Finally the wall-paper was suspected, and found upon examination to contain arsenic in large quantity. This paper was removed and a non-arsenical one put on, when the neuralgia speedily disappeared without medicine.*

The three following cases were characterized especially by attacks of fainting: —

17. A lady, who had been in feeble health for several years, suffered from steadily increasing prostration. "She was passing a considerable amount of urea and some sugar, which yielded to treatment. Not so, however, the prostration, as it steadily grew worse. Alarming symptoms now presented themselves, the patient fainting as many as ten times daily, and not recovering for upwards of half an hour from each attack. Sweatings, vomitings, and dryness of the mouth, together with intense prostration, almost closed her career, when I thought of the wall-paper, and found it loaded with arsenic. I immediately removed the patient, and sent her away for change of air, and she so much improved that I may say she is now well. A curious incident occurred in connection with this case. The children, owing to the upsetting in the house, were placed in the old room my patient had formerly occupied, and they were almost immediately seized with violent headache, vomiting, and other symptoms of poisoning; these subsided on their removal." †

18. Prof. Osborne Reynolds was in the habit of spending most of his time in his study. During his absence in July, 1876, the study was re-papered with a light bluish-green, unglazed paper. He returned home in August and spent two weeks in his study; in a day or two he began to feel poorly. A steady headache, and a faint sick feeling were the first symptoms; toward the end of the two weeks a sore throat came on. He left home and recovered, but returned again in October, when the same headache came on and gradually became worse; he fainted twice, and always seemed upon the point of doing so. He thought these symptoms were due to overwork, since he was always better,

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* F. E. Image, The Practitioner, 1880, xxiv, page 110.

† Sanitary Record, April 25, 1879, page 261.

when a little time away from home. He went away at Christmas for two weeks, and returned home better. After spending two days in his study, and at noon of the second day, he fainted. He then suspected the wall-paper, which was found, upon examination, to be arsenical. After its removal the symptoms did not return.*

19. "Mrs. S., having been engaged the greater part of the day in superintending house-cleaning, made an attempt to remove some dirt stains on the wall-paper of the bedroom (a French gray). In the course of the afternoon, and while so engaged, she became giddy and faint; these feelings were succeeded by dimness of sight, retching, cramp, and an inability to raise her arms and hands. When she was seen she appeared to be quite paralyzed, and was perfectly helpless. The suddenness of the attack, and the persistence of some of the very distressing symptoms, led to a more careful inquiry. Lead poisoning was suggested as the cause; but on passing the hand over the wall-paper of the bed-room, a quantity of coloring matter came off on the fingers. The dust removed, together with a piece of the paper, was sent to Mr. Heisch for examination. He reported that it contained an unusually large quantity of arsenic. The patient was removed for change of air, and made a perfectly good recovery." †

20. "A young married woman applied as an out-patient at the Westminster Hospital, complaining of 'queerness and strange feelings in the head.' These symptoms, she said, had come on quite suddenly, and had lasted now for about ten days. By further questioning, I learnt that the loss of memory of the performance of very recent acts, frequent giddiness, and some drowsiness, were the chief expressions of the 'queerness' she alluded to. She felt as if she were 'losing her mind.' Before this time, she had been in thoroughly good health, with no history of individual or family tendency to any nervous disease. There was no evidence whatever of any antecedent mental wrong or fright. All her systems were apparently in good working order. Beyond a slight degree of constipation I could find no abnormal condition. These facts were established by a careful process of

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* Sanitary Record, April 25, 1879, page 261.

† Ibid.

exclusive questioning. . . . As she was leaving the room, she told me that her husband was suffering in like manner, but that all his symptoms, especially the giddiness, were rather more marked. Some obvious external cause common to both these cases immediately struck me; and by chance I thought of arsenical wall-paper. The woman then told me that she and her husband had been sleeping for the last fortnight in a room hung with light-green paper." This paper was found to be highly arsenical.*

Cases in which enteritis was a marked symptom:—

21. A physician suffered for two years with occasional gastric and intestinal disturbances accompanied by slight fever. There was also a constantly increasing prostration, and an inability to work hard, either mentally or physically. The wall-paper on his office was a green velvet paper, the color of which proved to be almost pure Paris green, and two paper-hangers had symptoms of acute poisoning when they removed it. After its removal the gastro-intestinal troubles ceased. †

22. "A consulting physician had a severe attack of enteritis, with hemorrhage and great prostration. All the symptoms disappeared on the removal of the paper of his study. It contained a large amount of arsenic." ‡

23. "'For more than a year,' writes a practitioner of eminence, 'my own wife suffered repeated attacks (one of great severity) of enteritis. The patient was in the habit of sitting the greater part of the day in a room papered with green paper. Without any reference to the symptoms, the paper was accidentally changed to another color. It was noticed by me afterwards that the symptoms had disappeared. It then occurred to me that it might be due to the green pigment, and, on testing a piece of the old paper, I found abundance of arsenic.'" §

Cases in which skin eruptions were especially noticed:—

24. "The Rev. J. J. S. went to York, and he and his family took up their residence in the house of the former vicar. In a very short time Mrs. S. noticed that the children

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* H. B. Donkin, British Medical Journal, Nov. 4, 1876, page 587.

† Dr. Kelsey, New York Medical Journal, 1881, January, page 102.

‡ Report to the Medical Society of London. Practitioner, 1880, xxiv, page 235.

§ Ibid.

were suffering from a skin disease. A medical man was called in, but the disease proved intractable. On the occasion of one of his visits, he remarked to Mrs. S. that an only child of the Rev. Mr. G., the former occupant of the house, had suffered from a similar eruption, and had had a very narrow escape of its life from intermittent convulsions, and that the child immediately recovered after the family left York. Just about this time, letters appeared in some of the public journals on wall-paper poisoning; and the Rev. Mr. S.'s attention was thereby attracted to a brilliant green paper on the nursery walls. This was examined, and found arsenical. The children were at once removed, and the next day he sent for a tradesman to strip off the wall-paper. In the course of the day both he and his assistants were seized with cramps and sickness, and the reverend gentleman had to administer several doses of brandy and water to keep them at their work. The room was re-papered with a non-arsenical paper, and the children subsequently had no return of the skin affection." *

25. "The Rev. J. R., on his appointment to Helmingham, had the parsonage house put into thorough repair, and painted and papered throughout with various shades of green. Soon after taking up his residence with his family, the children were observed to be covered with a peculiar dusky skin eruption. On certain parts of the body and about the arm joints, the eruptive patches spread and ulcerated. The eyelids were also affected, and the disease proved obstinate. Change of air was recommended, and the children were removed, when a rapid improvement took place, and in two or three weeks they were able to return home. In a few days' time, however, the eruption again showed itself, and the skin became very irritable. Attention was then directed to the green paper on the walls of the nursery. This was examined and found very arsenical. On its removal, the children's health improved, and the eruptive disease entirely disappeared." †

Cases in which arsenical paralysis followed wall-paper

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* Jabez Hogg, M.R.C.S., British Medical Journal, June 14, 1879, page 892.

† Ibid.

poisoning, referred to by Seeligmüller in an article on "Arsenical Paralysis"*: —

26. Malmsten † reports one case of wall-paper poisoning, in which, after long-continued gastric symptoms, paralysis of all four extremities occurred.

27. Nicolaysen ‡ reports three similar cases. In one of these, a woman, sixty-three years of age, always lived in the winter in three rooms, the walls of which were covered with arsenical paper. She suffered from great gastric disturbance, pains in different parts of the body, and a feeling of nervous weakness and paralysis in the extremities, especially the lower. In the summer-time, when she went away, these symptoms disappeared.

28. H. O. Holm § mentions the case of a barber and his assistants, who, besides having headache and gastric disturbances, had symptoms of paralysis. The poisoning was due to their working in a small shop, which was decorated with arsenical wall-papers and curtains.

Case of poisoning by *blue* wall-paper: —

29. "A lady, whose health is generally of the best, complained of giddiness; severe headaches, especially on rising in the morning; constant drowsiness and lassitude, and a quite unwonted loss of energy. The giddiness was so marked as frequently to make her feel as though about to fall. There was no other complaint made, and no discoverable derangement of the digestive or any other system. She thought, herself, that her symptoms were due to cold and fatigue, and that she would soon recover by a temporary change of air. But I was struck with the fact that these symptoms dated as far back as the end of January, the time of my seeing her being towards the end of March. Previously to the end of January she had been in perfect health, with the exception of a 'cold.' And she was one of those who are not given to making vague or exaggerated complaints. The date, moreover, of the first definite notice being taken of these symptoms was about six weeks after entering a newly decorated house. . . . The color of

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* Deut. med. Wochenschrift, April 2 and 16, 1881.

† Hygeia, xxxv, and Schmidt's Jahrbuch. B'd. 165, page 238.

‡ Ibid. § Ibid.

the paper of the sitting-room in general use was one of the dull, 'æsthetic' greens now in vogue; that of the bedroom a light-blue and white." The latter was found very arsenical, "while the green paper of the sitting-room contained but very slight traces. The bedroom paper was at once taken down, and the symptoms promptly disappeared. On subsequent inquiry, I found that this lady had suffered from some slight smarting pain in the eyes, but had forgotten to mention this to me, believing it was due to over-use; and that she had also noticed a constant 'curious' taste on putting the tongue to the lips. Her husband, I afterwards learned, had recently complained of unwonted drowsiness and slight sore throat, though these symptoms were not much remarked at the time, and had not lasted so long as his wife's. Although experts are aware that it is not only green papers that are arsenical, yet even the educated public are in great ignorance on the matter. The dangerous nature, therefore, of some of these harmless looking papers, and the somewhat scantily recognized character of the nervous symptoms recorded, appear to give sufficient excuse for making this case public.*

30. Case of poisoning by *red* wall-paper: — Dr. George Garlick † reports several cases of poisoning in members of the same family by a red wall-paper. Two children were brought to the out-patient department of the Children's Hospital, Great Ormond Street. "Their mother, who brought them, gave the following account: The elder, a boy of eight years, had been suffering some time from pains in the eyes, nose, and different parts of the body. He passed restless nights, and was, during the day, depressed and inert. His digestion was feeble, and he had flatulence after food; his tongue was furred, pale, tremulous, and silvery; and the motions were described as offensive. There was, besides, a small patch of ill-developed psoriasis on the face. The other child, a little girl, also had pains in the eyes, nose, and shoulder, described as of a shooting character. Her tongue was also furred, and she had, like her brother, dyspeptic symptoms.

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* H. Donkin, M.B., F.R.C.P., British Medical Journal, 1881, i, page 681.

† The Lancet, Jan. 3, 1880, page 12.

"This remarkable combination of symptoms, viz., the local pains in the eyes and nose, with the presence of dyspepsia, suggested to me the possibility of arsenical poisoning, and, on further inquiry, this supposition was much strengthened by the remarkable statement of the mother, that she was much surprised at her children describing exactly the same symptoms as she herself felt, and that two of her other children at home suffered in the same way. In fact, with the exception of the father and one child, all suffered in the same way. She was accordingly directed to bring some of the wall-paper of the rooms they inhabited."

A sitting-room paper which had been on the walls two years was found to be arsenical. It was an inferior paper, and "consisted of red stars, stamped on a ground of pale-yellow and gray-brown." The arsenic was contained in the red pigment. "This is an interesting example of continued discomforts and deterioration of health, going on in a family for almost two years, owing to the existence of the poisonous paper. . . . After the paper was removed, the pain complained of in the eyes and nose at once ceased. The dyspeptic symptoms were more slow in mending."

31. Case of poisoning by *arsenical playing-cards*:—A lady "suffered from painful soreness of the tips of the fingers (*psoriasis unguium*), extending to the roots of the nails, which became, in consequence, altered and misshapen." The pain and tenderness were always increased by playing cards. The patient almost always used cards with a green back, since she was fond of them. "The discontinuance of the use of the cards soon led to a greatly improved state of the fingers. . . . Between the shuffling of the cards, and the warmth and moisture of the fingers, a considerable quantity of arsenite of copper will be detached and inhaled during the evening."*

The writer is also familiar with a case of poisoning, from the use of green-backed playing cards, one of which yielded upon analysis 0.126 grain of arsenic, or more than 6½ grains in the pack. An obstinate eczema of the hands was produced, but it disappeared after discarding the arsenical cards. Dr. Wm. Wallace* found in one playing card 1.6 grain of arsenic, and 0.91 grain of oxide of copper; or, in the whole pack, 83 grains of arsenic, and 47 grains of oxide of copper.

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* Jabez Hogg, M.R.C.S., British Medical Journal, Nov. 8, 1879, page 746.

32. Case of poisoning by an *arsenical book-cover:*—"A child in Troy, N. Y., while playing with some water-color paints, used a small book, attracted by the bright green color of its cover, for a palette. He mixed the paints on the cover of the book for some time. Then he was suddenly taken with convulsions. Physicians, who were hastily summoned, declared that he had been poisoned. They administered antidotes, but the child went into convulsion after convulsion, and it was only after three days' incessant labor that the physicians saved his life. They afterward investigated the manner of his being poisoned. They discovered that the dye with which the bright-colored book was covered contained the poison. In wetting the paints on the book-cover, the child had innocently wet also the dye, and soon transferred some of the poison to its own lips. There was a comical side to the investigation, although it was no consolation to the parents. The book was found to be a report of the society for the prevention of cruelty to children." † This report was that of the New York society, one of whose pamphlet reports was examined by the writer. The cover of this pamphlet was bright green, the coloring matter being almost pure Paris green. A sufficient amount of the cover could not be obtained at that time for a quantitative estimation of the arsenic. It resembled, however, one of the bright green, glazed papers mentioned above as commonly used in the manufacture of paper boxes, and also in kindergarten schools.

33. Case of poisoning by a *painted wall:* —"A surgeon suffered severely for several days from extreme depression, diarrhœa, griping, and asthma at night; and his wife, some days afterwards, being affected with similar symptoms, the paint of the sitting-room was suspected by the physician in attendance. It was found to contain a large quantity of arsenic." ‡

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* British Medical Journal, Oct. 18, 1879, page 630.

† Christian Register.

‡ Report of the Medical Society of London. The Practitioner, 1880, xxiv, page 235.

34. A case of poisoning from "French chalk" is recorded,* the chalk having been taken for heartburn. The inquest showed that death was caused by arsenical poisoning, the arsenic being contained in the chalk. "The chemist who sold the chalk said that he sold it, as purchased from a Manchester firm, and that he believed it was intended to be used by boot-makers."

35. Case of poisoning by *arsenical gloves:*—"A gentleman, Major Von B——, travelling from Schleswig to Berlin, bought in Hamburg a pair of marine-blue gloves and wore them; soon afterwards he became ill, and sought medical advice. His hands were covered with a peculiar eruption which his physician could not account for or understand, and he had a sensation of general weakness. On submitting the gloves to a chemical analysis, it was found that they contained a considerable quantity of arsenic, and this had been absorbed by the warm, moist hand." †

36. Mr. Carr also quotes a case of poisoning by *arsenical bed-hangings*, reported by Dr. George Owen Rees, consulting physician to Guy's Hospital. In this case the symptoms of poisoning lasted for many months before the source was discovered, but were finally traced to the green calico lining on the bed-curtains, which proved to be highly arsenical. On the removal of these the patient speedily recovered, although the symptoms had resisted all previous treatment.

37. The "N. Y. Sanitary Engineer" reports the following case of poisoning by *stockings* colored with aniline red: "A gentleman, holding an official position in a large railway corporation in this city, has just been severely poisoned by wearing stockings dyed red with aniline colors. He bought them in a furnishing store on Broadway, for ninety cents a pair, and wore them for some time, alternately with white hose, without any bad effect. Having occasion to travel to Chicago, however, he, as is customary, wore the red stockings at night, and soon after felt a disagreeable tickling sensation in the hollow of the foot. There was no special pain, and he did not feel any anxiety, but applied

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* British Medical Journal, July 12, 1879, page 57.

† Allgemeine medicinische Central-Zeitung, from Our Domestic Poisons by H Carr.

some salve. The irritation increased and running sores opened in the hollow of the foot, and also above the ankle and at the calf of the leg. The matter now looked serious, and he applied to Dr. Hurlburt, of Chicago, at once, who pronounced it a case of poisoning from aniline dyes, and said that he had had fifty similar cases within the previous three months. The gentleman was confined to his bed for ten days, but it was six months before he entirely recovered from the ill effects."

38. The following case of poisoning by a *dress* made of a material called "Foulard cambric," was communicated to the writer by the physician in charge of the case. He writes as follows, under date of Nov. 12, 1878: The patient "bought the dress-pattern at Jordan & Marsh's last spring, the salesman 'warranting the goods to wash and to be Foulard cambric.' . . . She made the dress not long after the purchase, but only wore it a day occasionally, until within a few days previous to her sickness, when she wore it for a whole week in perspiring weather. She then began to feel sickness, debility, and pain in the stomach — symptoms which were present for several days before the eyes became inflamed." A specimen of this cloth, the pattern of which consisted of narrow stripes of dark and light blue, was examined by the writer and found to be highly arsenical; later a quantitative estimation of the arsenic was made by Dr. C. Harrington, who found 0.291 grams of arsenic to the square meter, or almost one-half a grain (0.416) of white arsenic to the square foot of cloth.

39. The following case of acute arsenical poisoning from *fly-paper*, was communicated to the writer by a lady personally familiar with the facts of the case. A child, ten months of age, was placed by its mother in a high chair near a window, upon the sill of which was a saucer containing a piece of German fly-paper which had been prepared in the usual manner two days before, and had, therefore, become perfectly dry. The mother supposed that the saucer was out of the reach of the child, but she after awhile saw it reach over, take a small piece of the paper, and put it into its mouth; she immediately took it away, and removed, as she supposed, all of the paper from its mouth. This was at

about eight o'clock in the forenoon; in about ten minutes the child appeared distressed and vomited, two small pieces of the paper appearing in the vomitus; in about ten minutes more vomiting again occurred, two more small pieces of the paper being expelled. These pieces of paper were described as being "very small." Soon the child had convulsions, in which condition it remained, apparently in great distress, until nine o'clock in the evening, when it died.

Poisoning by inhaling fumes from burning arsenical wall-paper: —

40. The following case occurred in the practice of Dr. S. W. Abbott, health officer of the Massachusetts Board of Health, Lunacy, and Charity, to whom I am indebted for the following notes. "Jennie G., a native of the British provinces, was employed as a house-servant in Wakefield. I saw her in April, 1875, at which time she presented the following symptoms: — severe pain in the limbs, especially in the arms, thirst, nausea and vomiting, diarrhœa, œdema of the face and eyelids, conjunctivitis, tongue and gums red and swollen, and a metallic taste in the mouth. These symptoms had increased at succeeding visits. She was confined to her bed for several days, and eventually recovered. Arsenical poisoning being suspected, inquiry elicited the following facts: A few days previous to her illness some rooms were newly papered. She was employed in tearing the old paper from the walls, and in gathering the scraps and also the trimmings of the new paper. These were swept up and taken by her to the kitchen-stove, where they were burned, small quantities being put upon the fire successively, till all were consumed. In doing this she inhaled some of the fumes from the burning paper. No other persons in the family were affected, nor did the paper-hangers complain of any ill effects. Both the old and the new papers were submitted to chemical analysis, and the former was found to be arsenical; the latter contained none." †

41. Prof. B. Naunyn* reports the following case of poisoning, due to *arsenical paint* upon a wall. "I myself saw, two years ago, a case of this kind, where three persons, employed in the court-house at Königsberg, suffered with

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* Ziemssen's Cyclopœdia of the Practice of Medicine, page 652.

† This paper contained 201 milligrams per square meter, or 2.59 grains per square yard.

undoubted symptoms of chronic poisoning. All of the chambers of the court-house were painted yellow. Finally, the following proved to be the explanation of the source of poisoning: The public documents heaped up in the repositories on the side of the walls, had, by being placed in the compartments against the wall, gradually rubbed off the new yellow paint, and exposed to view an old green paint beneath; this was also continually being rubbed off, and there was found upon and in the papers, and in the compartments of the repository, a thick layer of green-colored dust, which, upon analysis by Dr. Blochmann, (at that time assistant in the chemical laboratory at Königsberg), was found to contain 8.32 per cent. of arsenious oxide. This dust — partly contained between and in the folds of the papers — was diffused throughout the whole building by handling and carrying the documents, and would be found upon the table whenever a bundle of papers was opened upon it."

42. Case of poisoning by *colored crayons:*—"A child, fifteen months old, was suddenly taken sick with symptoms of poisoning. There was abundant vomiting, and the vomitus was seen to contain bright green particles, which, when tested, gave the reactions of arsenite of copper. Antidotes, emetics, and a large quantity of warm water were given at once. Several hours elapsed before the green particles were entirely expelled from the stomach, and two days before they were entirely removed from the intestines. There was fever, swollen abdomen, and great prostration. The child's life was in jeopardy for four days, and convalesence was not established for eight days. The green-colored crayons, of which the child had eaten, contained 1.72 per cent. of arsenious acid."*

Legislation: — Several attempts have been made of late years in this State to secure legislation to prohibit the sale and manufacture of arsenical wall-papers, but in vain. The subject has also been much agitated in Europe, especially in England; and in some of the countries very stringent regulations exist, preventing not only the manufacture of poisonous articles, but also their sale and importation. The following condition of the laws existing in various European countries has been obtained from answers sent to the foreign office by English representatives at European courts, in reply to a circular addressed to them, at the request of the National Health Society.

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* Dr. Ch. A. Cameron, Revue d'Hygiène, ii, 1880, page 533.

Germany.

The German law of May 1st, 1882, with regard to the use of poisonous colors in articles of food, drink, and use, is as follows : —

"§ 1. Poisonous colors must not be used in preparing articles of food and drink which are intended for sale.

"Poisonous colors, in the sense of this order, are all coloring matters and preparations which contain : antimony, arsenic, barium, (except 'heavy spar' — sulphate of barium), lead, chromium (except pure protoxide of chromium), cadmium, copper, quicksilver (except cinnabar), zinc, tin, gamboge, picric acid.

"§ 2. The keeping and packing of articles of food and drink, intended for sale, in covers dyed with poisonous color (§ 1), or in vessels which are so prepared with poisonous color (§ 1), that some of the poisonous matter might mix with the contents of the vessel, is forbidden.

"§ 3. The use of the poisonous colors named in § 1, with the exception of oxide of zinc and chrome-yellow (chromate of lead) in varnish or oil-paint, is forbidden in the manufacture of toys.

"§ 4. The use of colors prepared with arsenic is forbidden in the manufacture of paper-hangings, and so is the use of copper colors prepared with arsenic and stuff containing such colors in the fabrication of articles of apparel.

"§ 5. Sale, and exposure for sale, of articles of food or drink, which are prepared, kept, or packed contrary to the provisions of §§ 1 and 2, and of toys, paper-hangings, and articles of apparel, contrary to the provisions of §§ 3 and 4, are forbidden.

§ 6. This order comes into force on the 1st of April, 1883." *

Russia.

The following extracts from the medical statutes, vol. xiii, of Code edition, 1876, show the regulations with regard to the use of poisonous pigments in articles of domestic use in Russia : —

"§ 843. *Observation.* —With a view of preserving the national health against the injurious effects arising from the employment of articles colored with poisonous paints and dyes, the following measures shall be adopted: —

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* Correspondence respecting the presence of arsenic and other poisonous pigments in wall-papers and textile fabrics. Presented to both houses of Parliament by command of Her Majesty, 1883.

"1. The importations from abroad, as well as the sale and manufacture in Russia, shall be prohibited of wall-paper covered with a thick coating of arsenical coloring matter, both opaque and glazed.

"2. The importation from abroad, and the sale and manfacture in Russia, shall be prohibited of light tissues, such as organd, tarlatane, muslins, etc., completely dyed with arsenical coloring matter.

"3. Exception to these rules shall only be made in favor of wall-paper, and for tissues in which the patterns, flowers, leaves, moths, stripes, etc., are alone traced in arsenical paint on a more extensive ground of non-arsenical coloring matter.

"4. The interdiction of all importation into and manufacture and sale in Russia shall also be extended to children's toys of all kinds colored with arsenical paint, and to paper wrappers for wrapping up and ornamenting comfits and other sweetmeats and edibles.

"5. Children's toys may be covered with other non-arsenical paints, but on condition that they be mixed with oil.

"6. The employment of substances injurious to health for coloring articles of food and sweetmeats, such as comfits and gingerbread, marmalade, pastille ices, etc., shall be entirely prohibited.

"7. The sale and circulation generally of paper known as '*papier nacre*,' and preparation of visiting cards, bills of fare, wrappers, and such articles made of this paper, shall be prohibited." *

The Russian law (1868) gives the following list of "Injurious Pigments and Paints."

White. White lead, "Kremnitzweiss" and "Schieferweiss" (both prepared from lead); carbonate of zinc.

Red. Cinnabar (mercurial); red lead (minium); red copper paint ("Kupferroth"); chrome red; English red paint (mineral red); lead glance or galena; Florentine or carmine paint, containing arsenic (Florentina lac); "Karminroth," so called.

Yellow. Orpiment or sulphide of arsenic (*Auri pigmentum*); King's yellow; Cassel yellow; Neugelt; Naples yellow; massicot (yellow lead); English yellow; mineral yellow; chrome yellow; gamboge; yellow bronze; and Paris yellow.

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* Ibid, page 20.

Orange. Compounds of the above yellows and reds with the following.

Blue. Cobalt ("Bergblau"); mineral blue with cobalt; Bremen and Königsblau; smalt containing zinc or copper; blue ore ("Blauer-Erzglanz"); blue friable sand ("Blauer-Strenglanz"); Eschel; Silberblau; Loerisenblau; Vienna and Leutheuerblau.

Violet. Mixtures of the foregoing blue and red pigments.

Green. Verdigris ("Grünspan"); verdigris crystallized ("Grünspanblume," "Braunschweigergrün"); Berg green; Bremen and Swedish green; Scheele's green; Vienna green; Schweinfurt green; Kirchberg green; Paris green; Berlin green; new green; oil green; green bronze; Kaiser green; Mitis green; English green; Kassel green; moss green; parrot green; chrome green; cobalt green; green cinnabar; May green; Naples green; Neuwieder green; mineral green; zinc blende; and all greens composed of injurious yellow and blue pigments.

Brown. Compounds of injurious reds with blacks.

Metallic. Gold and silver tinsel; gold and silver bronze; copper bronze; crude antimony.

SWEDEN.

The Swedish law is by far the most stringent, the manufacture, importation and sale of white arsenic being controlled by the strictest regulations. It even prohibits the sale of arsenic "in any shape for the purpose of destroying flies, or rats and other noxious animals, or the embalming or preserving of dead bodies, no matter who may have prescribed or ordered the same." The same regulation is also applied to other poisons, such as strychnine.

The decree of 1876 provides that, —

> "Children's toys in water colors (with glue, gum, starch, dextrin, etc.,), painted in poisonous colors, shall not be kept or offered for sale; nor color-boxes, unless furnished with distinct labels written in the Swedish language, indicating whether they contain *poisonous* or *not poisonous* colors.
>
> "Confectionery, articles in tragacanth, ices, pastry, cordials,

syrups, or other articles intended for consumption, which are painted or tinted in poisonous colors, shall not be kept or offered for sale; and the board of health shall . . . publish a list of such substances as may, without any detriment to health, be used in the coloring or ornamenting of such articles.

"It is likewise prohibited to keep for sale sweetmeats and other articles intended for consumption, if they be poured out into lead foil, or into paper which is colored, painted, printed, or glazed in poisonous colors or in tin-foil, containing more lead than ten per cent., and also if they are wrapped up in such covers without being first inclosed in innocuous paper.

"Wall-paper, window blinds, Venetian blinds, tissues, artificial flowers, or other articles in water color (with glue, gum, starch dextrin, glair, etc.), printed or painted in colors containing arsenic, shall not be kept or offered for sale.

"The same prohibition shall also apply to lamp-shades, sealing-wax, wafers, stearine candles, and other candles containing colors that contain arsenic, or other substances that contain arsenic." *

In 1883 a decree was issued modifying the above Swedish law in such a manner as to regulate the maximum amount of arsenic which should be permitted in articles of domestic use, as follows: —

"Wall-paper, window blinds, Venetian blinds, artificial flowers, or other articles in water color, printed or painted (with glue, gum, starch, dextrine, glair, etc.), in colors containing arsenic, shall not be kept or offered for sale if, out of 440 square centimeters (50 square inches) † of the article, or less, there can be educed at a chemical analysis, from the sulphuret of arsenic then obtained, by reduction with cyanide of potassium and carbonate of soda, metallic arsenic precipitated (sublimed) as a black or blackish-brown, at least partially opaque mirror (arsenic mirror, "arsenikspiegel") in a glass tube of 1½ to 2 millimeters (½ to ⅔ line) inner diameter.

"The same prohibition shall also apply to stuffs, textiles, yarn, lamp-shades, sealing-wax, wafers, stearine candles and other candles containing colors, or other substances that contain arsenic, if arsenic, in the manner and to the extent above stated, can be educed out of 220 square centimeters (25 square inches), or less, of stuffs, textiles, and lamp-shades, or out of

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* Ibid., page 34.

† 68.2 American square inches.

21 grammes* (5 ort), or less, of other articles enumerated above." †

The law also provides that the analysis must be performed by an expert chemist, who must give a certificate of prescribed form as to the result of his analysis, and return with the certificate an exhibit of the metallic arsenic obtained, and a piece of the goods examined of sufficient size for its identification, and for another analysis if necessary.

Austria.

In Austria the importation from abroad of "dried fruits painted over with colors; playthings, plates and dishes made of terra-cotta of a greenish golden hue; children's toys painted over with preparations injurious to the general health; artificial flowers and the materials therefor colored with arsenical preparations, upon which the color is either laid on as paint or sprinkled on like dust; textile fabrics colored or printed with arsenical preparations, wall-papers of the same kind, white paint for the face" is subjected to police restrictions, and such articles can be obtained from the principal custom houses only by special permission.

There is no law prohibiting the use of arsenical colors in paper, lamp-shades, envelopes, wafers, sealing wax, candles and similar articles, but the government requires "the local authorities to use their influence in drawing the attention of the public to, and warning them in the public journals, etc., of, the injurious qualities of such articles if incautiously employed."

A decree was issued Nov. 27, 1876, prohibiting the use of aniline colors of every kind (red, blue, green, etc.) in the manufacture of articles intended for consumption, and the penal code prohibits "the employment of mineral colors in eatables; the application to stuffs destined to come in contact with the human body, of mineral colors containing copper, arsenic, lead, zinc, and other poisonous metallic preparations; as well as starching textile fabrics with starch in any way composed of such mineral colors; the application of litharge or bad enamel to table and kitchen utensils, or such articles used as children's playthings."*

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* 323 grains.

† Correspondence respecting the presence of arsenic and other poisonous pigments in wall-papers and textile fabrics. Presented to both houses of Parliament by command of Her Majesty, 1883. Page 41.

Baden.

The imperial law of May 10, 1882, prohibits the use of colors containing arsenic in the manufacture of wall-papers, and of colors containing copper and arsenic for dyeing clothing. In 1865, "the tinting of walls or ceilings of dwelling-houses or factories with arsenical compounds," and "the use of arsenic in coloring any articles whatever, except such as are specially permitted by the authorities," was prohibited.

Bavaria.

The law is the same as that of the German empire. "Those persons are liable to punishment who fabricate articles of clothing or wall-papers in such a way that the ordinary or probable use of these articles would tend to be injurious to the health of human beings; as are also those who sell, offer for sale, or otherwise bring such articles into the market." †

The imperial ordinance of May 1, 1882, prohibits the use of arsenical colors in the manufacture of wall-papers and textile fabrics.

Denmark.

The law of 1843 prohibited the employment of poisonous matter for coloring confectionery, wafers, and toys; and also the sale of such articles, none being permitted except those sanctioned by the board of health.

A project of a law, Dec. 1, 1879, forbade the use of arsenical compounds in staining, dyeing, or coloring stuffs, blinds, artificial flowers, lamp-shades, paper, sealing wax, wafers, or candles, or for the coloring of the walls of rooms or wall-papers; for painting or staining toys; for coloring articles of confectionery, food, drinks, or preparations for the teeth; and boxes of colors containing arsenical colors must be labelled "poisonous colors."

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* Ibid., page 3.

† Ibid., page 5.

FRANCE.

No regulation exists except with reference to articles of food or drink.

HESSE–DARMSTADT.

The use of pigments "injurious to health" is forbidden in the manufacture and sale of confectionery, toys, furniture, paint for walls of a dwelling-room and wall-paper; Scheele's green, Schweinfurt green, King's or Naples yellow, as well as all colors containing arsenic or combinations of arsenic are designated as pigments "injurious to health."

SAXONY.

The Saxon regulations of 1856 prohibited the use of an arsenical red pigment known as Munich red, cochineal red, and Pernambuco lake (Brazil red) for paper-hangings, colored paper, and for staining.

A regulation of 1860 prohibited the sale of articles colored with Schweinfurt green, and a regulation of 1868 prohibited the manufacture and sale of window-blinds colored with arsenical pigment.

ENGLAND.

Strenuous efforts have been made in England to obtain an act prohibiting the manufacture, importation, and sale of articles of domestic use colored with arsenical pigments, or containing arsenic in any form, especially by Jabez Hogg, M.R.C.S., T. Lander Brunton, M.D., F.R.S., and Messrs. H. Carr, H. C. Bartlett, Chas. Heisch, F. de Chaumont, and many others. Up to the present year these efforts have been unsuccessful; but a vast amount of material, showing the extent of the use of arsenical pigments, the dangers to the public health resulting therefrom, and the precautions taken in other countries, has been collected and presented to Parliament for consideration.

The members of the National Health Society have been indefatigable in their efforts to suppress the extensive use of arsenic in domestic fabrics, and have succeeded in interesting some of the wall-paper manufacturers, who state that the use of arsenical pigments is not essential in the coloring of wall-papers, and that non-arsenical pigments of every color can be obtained of equal brilliancy and durability.

A sub-committee of this Society reports in regard to the amount of arsenic which should be permitted, and the test which should be employed, as follows: "The first point for consideration is whether the prohibition of arsenic must be absolute, extending to the most minute trace, or whether such minute quantities may be allowed as arise from accident or unavoidable contamination. A very large proportion of fabrics of all kinds are found absolutely free from arsenic, no known test discovering the slightest trace; but, again, with regard to many fabrics, some traces are unavoidable in consequence of the very wide diffusion of small quantities of arsenic in natural products. The consideration consequently arises: first, as to what amount of arsenic it is requisite to allow as unavoidable and accidental contamination, in order that trade may not be hampered or interfered with to any undue extent; and next, whether that allowance may be permitted with due consideration to health. There are manufacturers of wall-papers (the principal articles in question) who have, on principle, abjured the use of all arsenical colors; the result of their work affords, therefore, an excellent guide for what may be demanded without unreasonable interference with the freedom of trade. An examination of a very large number of papers supplied by these manufacturers, leads to the conclusion that an allowance of one-half a grain of arsenic per "piece of paper" — a piece being twelve yards in length and twenty-one inches wide — would be ample for accidental and unavoidable contamination; and this quantity, it is considered, would not be injurious to health. It is found that suitable size for a sample to be tested is sixteen square inches, to be cut from one part; or, if thought well, from several parts of the pattern, so as to include all the colors. The proposed limit of one-half a grain per piece gives 0.001 grain per sample of sixteen square inches. For ordinary uniform materials, a square of 4×4 inches may, therefore, be taken as the portion to be tested. We may remark that the quantity of arsenic which we allow to pass, by these tests, is more than four times as much as would be permitted by the Swedish decree. We were at first of opinion that Reinsch's test, carefully conducted, so as to ensure uniformity of results, might be employed; but several wall-papers and many textile fabrics having been found which gave no arsenic reaction with Reinsch's test, however carefully conducted, but which, nevertheless, were subsequently proved to contain noticeable quantities of arsenic, this method was proved not to be an absolutely reliable test. A modification of Marsh's test is recommended as the most reliable, and as most suitable for a standard test to be inserted in an Act of Parliament. Detailed instructions are joined for both tests, in order that those who still desire to use Reinsch's method may get results comparable with the prescribed test by the modification of Marsh's process, where arsenic is found.

" *Standard Test.*

"No paper should be passed as 'non-arsenical,' unless, when treated as hereafter described, it fails to yield a mirror in a tube one-eighth of an inch internal diameter, sufficient to cut off at any point a black line on a white ground, technically known as thick rule (eight to pica)."

Specimen Line.

The "modification of Marsh's test" proposed by the committee is fully described, and is briefly as follows: The apparatus consists of a ten-ounce flask or bottle provided with three necks, a chloride of calcium drying tube, and the exit tube of one-eighth inch internal diameter. One opening in the flask is provided with a funnel-tube for the introduction of the acid, the second with a bent tube to connect with the drying tube, and the third with a tight stopper which is removed for the introduction of the wall-paper, which is cut up and put directly into the apparatus at the proper time. Two hundred grains of zinc, which is absolutely free from arsenic, is first placed in the flask, and two fluid ounces of dilute hydrochloric acid (one part acid to eight of water) added. After the action has continued for a sufficiently long time to ensure the complete expulsion of air, the gas issuing from the exit tube is ignited. The exit tube is passed through a clay chimney 1$\frac{3}{4}$ inches in diameter, in which the heat is applied to decompose the arseniuretted hydrogen passing through the tube; just outside the chimney the exit tube is cooled to facilitate the condensation of the metallic arsenic formed by the decomposition of the gas. After the paper has been introduced into the flask, the tube is kept heated for one hour, and if, at the expiration of this time, an arsenical mirror of sufficient density to cut off the specimen line has not formed within the tube, the paper is pronounced non-arsenical. Papers which contain compounds of sulphur give rise to the evolution of sulphuretted hydrogen, in which case sulphur deposits inside the tube with the arsenic, obscuring the mirror formed by the latter; to prevent this an exit tube is used, one part of which has $\frac{1}{4}$ inch internal diameter and the rest $\frac{1}{8}$ inch internal diameter; the wider portion is filled with black flux, which is kept in place by a plug of asbestos at each end; the sulphur is retained by the black flux, while the arsenic, if present, passes on and is condensed outside the chimney in the form of a mirror.

The committee concludes its report as follows: "We recommend the society to adopt and publish the proposed test, as a standard test according to which wall papers, and other materials described in Appendix A,* may be classed as 'arsenical' or 'non-arsenical,' and their manufacture or importation be regulated accordingly." †

The method which the writer has always adopted for testing wall-paper for arsenic is much less delicate than that proposed by the National Health Society. It is as follows: A piece about four inches square is cut up into small pieces, and heated in an evaporating dish upon a sand-bath after being thoroughly moistened with concentrated *pure* sulphuric acid; this procedure chars the paper, and thus practically destroys the organic matter. The charred mass is extracted with distilled water and filtered; the filtrate will contain most of the arsenic in solution, and is introduced directly into a Marsh's apparatus which has been in operation for a sufficient length of time to ensure the complete expulsion of air from the apparatus, and to permit the ignition of the gas issuing from the exit-tube. Before introducing the extract from the wall-paper, a porcelain plate is introduced into the jet of burning gas in order to determine whether a sufficient amount of arsenic exists in the sulphuric acid and zinc used in the test to produce an arsenical mirror upon the porcelain plate ; if no mirror is produced, the chemicals are considered sufficiently pure, although their purity has previously been determined by a much more delicate test. This having been established, the extract from the wall-paper is introduced into the apparatus through a funnel-tube, when, if the paper is arsenical, the jet of burning gas will very quickly become blue, and a porcelain plate introduced into the flame will be stained brown or black by the decomposition upon it of metallic arsenic from the inside of the flame, in the same way that lamp-black is deposited upon a glass or porcelain plate when depressed into a candle flame. If no such mirror is produced, the paper is considered non-arsenical. The writer prefers, however, the method proposed by the London society as being more delicate, and as being more even in its results. The only objection which can be made to the method heretofore used by the writer is, that very small quantities of arsenic may escape detection ; but when arsenic is detected by this method, there can be no doubt as to the result, the purity of the chemicals being ascertained beforehand.

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* See page 226.

† British Medical Journal, June 23, 1883.

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